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New York

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JOURNAL

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AMERICAN WELDING SOCIETY
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Our New President

Mr. F. T. Llewellyn, the new president of the American Welding Society, was born in Cardiff, Wales, in 1869. He taught school and attended the University of London from 1886 to 1889 and came to this country late in 1890. His first position was in the

F. T. LLEWELLYN

structural steel department of the Gillette-Herzog Manufacturing Company, Minneapolis. Four years later he was appointed Southern engineer of the same firm and was located at New Orleans in charge of construction. He supervised the first steel skeleton tier building in New Orleans and the first steel frame building in Louisiana. He was a charter member of the Louisiana Engineering Society. In 1900 he had charge of the construction of the first steel frame building in Mexico City. While abroad, his company was absorbed by the American Bridge Company. In 1902 he became contracting manager of the American Bridge Company at St. Louis and later in New York.

From 1906 to 1917 he was engineer in the New York office of the Carnegie Steel Company and devoted his attention to the developments of new products. In 1917 he was loaned to the Emergency Fleet Corporation and devoted his attention to the simplification of steel requirements for ships, and in allotting steel to shipyards.

From 1919 to date he has been attached to the president's office of the U. S. Steel Corporation and has concerned himself with the development of new products, especially in the structural field.

In the last few years, Mr. Llewellyn has become very much interested in welding and its application to the structural steel welding. Combining the qualities of a clear thinker and congenial personality, he brings much prestige to his new position as president of the American Welding Society.

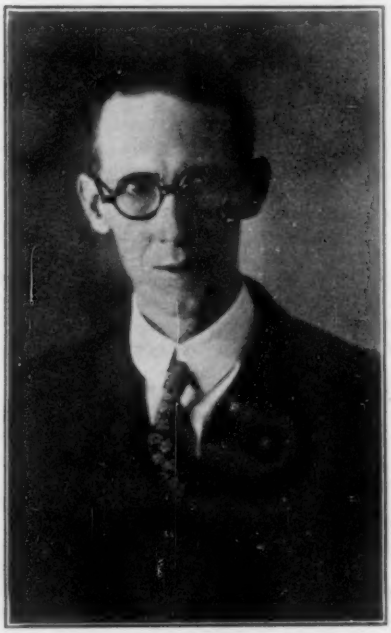
Mr. Llewellyn has been a member of the executive committee of the Society and active on the Structural Steel Welding Committee. He is a member of numerous organizations, among which are included: American Society of Civil Engineers, American Society for Testing Materials, American Society for Steel Treating, American Welding Society, American Society of Naval Architects and Marine Engineers, Licensed Engineer, New York State, Brooklyn Engineers' Club, Engineers' Club (New York), Pittsburgh Athletic Club, Newark Athletic Club, Montclair Chess Club (Charter), Montclair Glee Club (Former Charter).

His hobbies are music, chess and mathematics.

Mr. J. W. Owens Wins $10,000 Prize

James W. Owens, director of welding of the Newport News Shipbuilding & Dry Dock Company, was awarded the first prize of $10,000 for the best paper on arc welding submitted in the Lincoln Electric Company's International Competition under the auspices of the American Society of Mechanical Engineers.

Mr. Owens was born Feb. 14, 1886, of British parentage, on the Island of St. Eustatius in the Dutch West Indies. His early education was secured under adverse conditions, his father, Rev. J. P. Owens, a Wesleyan Methodist minister, being stationed in British Guiana, Barbados, Trinidad, Tobago and other islands of the West Indies. While in Barbados he took a general science course at Harrison College, the instructors of which are graduates of Oxford, Cambridge and Edinburgh universities. In 1904, or at the age of 18, he came to the United States with a determination to follow engineering, the profession of his choice. His first job was that of a wireman's helper with the New York Edison Company. He took an evening course in electrical engineering, for a period of three years, at the Polytechnic Institute at Brooklyn, N. Y., and from 1904 to 1918, when he entered the welding field, he worked for some of the largest engineering concerns in New York City on the design and installation of multiple unit car control equipments and on the design and construction of power stations.



J. W. Owens

His Development of Welding for the Navy

In the spring of 1918, he became associated with the Welding Research Committee of the Emergency Fleet Corporation. On this committee he attracted the attention of Commander H. G. Knox, then shop superintendent of the Norfolk Navy Yard, and in the fall of that year was appointed arc welding expert at the Norfolk Navy Yard. At the Navy Yard he assisted Commander Knox to organize the first welding shop in the navy in which all of the welding processes were employed; inaugurated an extensive welding research and educational program; trained welders and welding supervisors for practically every east and west coast Navy Yard. Among the many projects supervised by him at the yard were the comparative construction of riveted and the first completely metal arc welded battle towing targets. These welded targets so clearly demonstrated to the navy the possibility of welding as a means of lowering the cost of construction and the service tests were so satisfactory that the navy has given up the construction of riveted targets and built at least seventeen completely welded targets to date. While at this yard he was called upon to assist the Boston Navy Yard in their welding development and inaugurated there the first systematized test of welders in the navy to determine their ability to make consistently sound welds in all of the positions met with under practical conditions. This test is now required of all welders in Navy Yards and in private shipyards engaged in naval work.

His work at the yard was not confined to ship construction, for he was called upon by the Bureau of Aeronautics to conduct a research on

welded joints in aircraft construction. Just prior to his resignation, Mr. Owens prepared for the Bureau of Construction and Repair the welding specifications and preliminary welded designs for the scout cruisers now under construction.

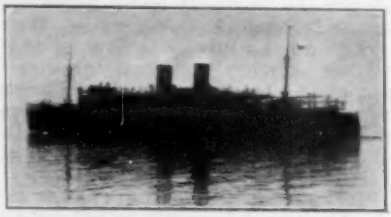
During a period of four years and while carrying on the extensive research and development program at the Norfolk Yard, and which has been previously referred to, Mr. Owens wrote his book, "Fundamentals of Welding—Arc, Gas and Thermit." Rear Admiral David W. Taylor, Chief Constructor of the Navy during the war, states in his foreword to this work that "It is due largely to Mr. Owens' research and investigations that we make such liberal use of welding on naval vessels—he has gone far to reduce an art of many obscurities and perplexities to a science."

Welding Development at the Newport News Shipyard

When Mr. Owens took up his duties with the Newport News Shipbuilding & Dry Dock Company in Newport News, Va., as their director of welding, on Jan. 1, 1926, the yard had twenty-two metal arc welders, and, although more or less equipped to employ the various welding processes, nevertheless the utilization of the fusion welding processes in new construction was negligible. Except in the manufacture of rack rakes, a limited number of tanks, vent ducts and in locomotive repair, welding was primarily used to salvage defective castings and to fill mis-punched holes in structural work. During the two and a half years in which he has been associated with this company, welding has assumed the status of an operating department and is now extensively used on all classes of steel construction work undertaken by the company, including ship construction, building construction, pipe lines and hydraulic work in general. At the present time there are about sixty metal arc and eleven gas welders on the rolls.

In ship construction, the Newport News shipyard used metal arc welding more extensively in the construction of the Coast Guard cutter "Northland," launched Feb. 5, 1927, than any ship of its size constructed in the world up to that time. Its decks and superstructure are very largely welded; it has a completely welded rudder and four seams at the waterline are welded in addition to being riveted in the usual manner, so as to enable the hull to more effectively resist ice pressure in Arctic service. At the present time approximately 600 lb. of electrodes is being used per day and a total of 30,000 lb. were used on the S. S. "California" of the Panama Pacific Line, which was launched Oct. 1, 1927. It is probable that 60,000 lb. of electrodes will be used on her sister ship, the S. S. "Virginia," which is now under construction.

In steel building construction there has been erected a 50 ft. x 60 ft. completely metal arc welded extension to the company's foundry cleaning room, together with a 10-ton, 50-ft. span, overhead traveling crane which will serve this building.



S. S. California

Societies and Clubs

Mr. Owens was one of the charter members of the American Welding Society and the American Bureau of Welding, the research department of this Society. He was vice-president of the American Welding Society from 1920 to 1922 and is at the present time chairman of its Nomenclature Committee, a member at large of the American Bureau of Welding. He is also member of practically all important technical committees of the American Welding Society and the American Bureau of Welding. He is a Fellow of the American Institute of Electrical Engineers, a member of the Hampton Roads Engineers Club, the Newport News Chamber of Commerce, the Cradock Norfolk County Chamber of Commerce, the Tidewater Club and the Newport News Golf Club.

Members of the American Welding Society join in wishing Mr. Owens continued success and happiness.

Lincoln Arc Welding Contest Prizes Awarded at Spring Meeting of A. S. M. E.

Ten thousand dollar first prize won by shipyard welding superior; Belgian professor captures second money; third place award goes to United States Naval Commander.

Seventeen thousand five hundred dollars, donated by The Lincoln Electric Company, Cleveland, Ohio, was distributed at the opening session of the spring meeting of the American Society of Mechanical Engineers held at the William Penn Hotel, Pittsburgh, Pa., on May 14. The occasion was the awarding of prizes to the winners of the Lincoln Arc Welding contest, which closed Dec. 31, 1927.

James W. Owens, director of welding for the Newport News Shipbuilding and Drydock Company at Newport News, Va., won the first prize of $10,000. Owens is a past vice-president of the American Welding Society and a fellow of the American Institute of Electrical Engineers. He is also author of the text book "Fundamentals of Welding."

Five thousand dollars, the award for the second best paper submitted, was won by Henri Dustin, professor in the Engineering School of the University of Brussels, Belgium, and director of the Laboratory for Material Testing. Third place award, $2,500, was given to Commander H. E. Rossell, Construction Corps, United States Navy, instructor of mathematics at the United States Naval Academy at Annapolis. Honorable mention was given to the papers submitted by Frank B. Walker, Winthrop, Mass., and B. K. Smith, president of the Big Three Welding and Equipment Company, Houston, Tex.

Before formal award of the prizes, J. C. Lincoln of The Lincoln Electric Co. outlined briefly the purpose of the competition and thanked the society for sponsoring the awards and assisting in making the public welding minded. The prize winners were presented their awards by Alexander Dow of Detroit, Mich., president of the Detroit Edison Company and president of the society, and L. F. Alford of New York, chairman of the committee of judges. Other members of the judges' committee representing the American Welding Society, American Institute of Electrical Engineers, American Society of Mechanical Engineers, American Society of Civil Engineers and the United States Bureau of Standards, were S. W. Miller, Comfort A. Adams, Henry Goldmark, F. T. Llewllyn, George K. Burgess, W. F. Durand and Robert H. Fernald. J. C. Lincoln and J. F. Lincoln of The Lincoln Electric Company, Cleveland, Ohio, were advisory members of the judges' committee.

Seventy-seven papers were submitted in competition for the prizes, of these thirteen were entered by residents of foreign countries. The little country of Belgium was represented by the most entrants of any foreign country, England ranking second.

The task of ferreting out the most deserving papers was a stupendous one for the judges. Sixty-six papers were rejected after the first reading and the remaining eleven reread by each of the judges. The final selection was determined by letter ballot, the Owens paper, "Arc Welding, Its Fundamentals and Economics," receiving a unanimous vote for first prize.

Author Owens explained his paper's title as "a treatise on the fundamentals of arc-welded design and shop practice, and an analysis of its industrial application and worldwide possibilities." He divided his treatise into eight sections and an appendix, which were titled as follows:

I—The Advantages of Arc Welding.

II—A Brief Outline of the Fundamentals of Design and Shop Practice necessary to Insure the Extensive Economic Use of Arc Welding.

III—A Discussion of the Principal Stock Objections to the Use of Arc Welding.

IV—A Description of Some Recent Outstanding Applications of Arc Welding.

V — Comparative Riveted and Welded Designs of a Large Freight Ship.

VI—The Relative Weight, Cost and Economy of Riveted and Welded Ships.

VII—Effect of the Full Utilization of Arc Welding on Shipyards and On Industry in the United States.

VIII—Summary and Conclusions.

Appendix—Arc Welding Definitions, Nomenclature, Symbols, Weld Gages,

Design Data, Fundamental Specifications, Tentative Standards for Ships' Hulls and Machinery, List of Arc Welding Applications to Ships' Hulls and Machinery, Miscellaneous Illustrations.

Over one hundred photographs, charts, tables and drawings illustrated the text matter.

Professor Dustin's prize money paper deals with the strains set up in welded joints and methods of calculating such strains. The Belgian contributed much basic information which will be very valuable for use in the preparation of handbook data. Research work in South America prevented the professor from attending the awarding of the prizes.

E. B. Rossell, brother of the prize winning commander, received the third place award for his brother. Commander Rossell entitled his contribution "Electric Welding of Ships' Bulkheads and Similar Plated Structures." He devoted over 100 pages to his profusely illustrated text and supplemented it with a large number of comprehensive tables and charts. The manner in which the naval officer handled his subject indicated extensive research and intelligent study.

B. K. Smith, in his honorable mention paper, "Stable Arc Welding on Long Distance Pipe Lines," gives a vivid account of the field welding of a 45 mile gas line which passed through a thick forest, over ravines, hills and ditches and under a deep river. Included in this paper is also complete cost studies proving the many advantages of electric arc welding for pipe line work. The other entry in the contest to receive honorable mention was labeled "Theory and Application of the Base Plate Arc Welded Rail Joint," by Frank B. Walker. This is an extensive treatise on a new type of rail joint for electric railroad tracks in which the author gives many test data to support his theories.

Appointment of Committees

At the Executive Committee meeting of the American Welding Society, held on April 24, the following committee appointments were announced:

Welding Code for Pressure Vessels.—The purpose of this committee is to prepare a general code for procedure to be followed in welding of pressure vessels, which will be submitted to the American Society of Mechanical Engineers' Boiler Code Committee, for their consideration and possible incorporation as part of the code. The committee members are: Messrs. C. W. Obert, chairman; G. R. Brophy, L. H. Burkhart, A. M. Candy, J. J. Crowe, F. C. Fyke, H. H. Moss and J. W. Owens.

Welding Code for Pressure Piping.—At the request of the Sub-Committee on Welding of the Power Piping Code Committee of the American Engineering Standards Committee, the American Welding Society was requested to prepare the first draft of such a code. The committee members who will have this work in charge are: Messrs. D. H. Deyoe, chairman; A. M. Candy, J. J. Crowe, J. H. Deppeler, F. C. Fyke, S. W. Miller, H. H. Moss, W. Spraragen and W. Schenstrom.

A. W. S. Conference Committee on Welding of Boiler Code Committee.—This committee is to assist the welding sub-committee of the American Society of Mechanical Engineers' Boiler Code Committee in answering questions referred to the Boiler Code Committee relating to welding. The committee members are: Messrs. C. W. Obert, chairman; A. G. Bissell, G. R. Brophy, L. H. Burkhart, J. J. Crowe, F. C. Fyke, H. H. Moss and J. W. Owens.

Structural Steel Welding Committee

Progress Report of Activities

The Structural Steel Welding Committee was organized in 1926 under the auspices of the American Bureau of Welding, with the cooperation of the American Institute of Steel Construction, The American Society of Civil Engineers and others. It included structural steel engineers, fabricators and welding experts under the chairmanship of Mr. J. H. Edwards, chief engineer of the American Bridge Company.

The following sub-committees were appointed:

(1) Review of Literature.
(2) Specimen Design.
(3) Specimen Procedure.
(4) Ways and Means.
(5) Testing.

The Sub-Committee on Literature made a digest of all available published data giving test results which would be of assistance to the commit-

tee, and a summary of this digest was published in November, 1927, issue of the Journal of the American Welding Society, and copies sent to each member of the committee.

The Sub-Committee on Specimen Design laid out 191 different designs and sizes of welded joints whose tests would give unit values applicable to conditions of design most commonly met in structural steel work. A marking system was developed that would identify specimens prepared in different shops.

The Sub-Committee on Specimen Procedure took these designs and laid out a procedure, specifying how multiple specimens of each type and size should be made up, including the qualification of welders, the technique to be followed, supervision and inspection.

In order to obtain a preliminary trial of the specifications covering the making and testing of specimens, several hundred pilot specimens were made and tested through the courtesy of the University of Toronto, under the supervision of Professor Peter Gillespie. These pilot tests brought forth the desirability of a number of changes in the specimens and in the procedure specifications.

As soon as the results of the pilot tests were available, the proposed program was divided into sections, covering, A—General Information; B—Qualifications of Welders; C—Specifications for the Preparation of Specimens; D—Inspection and Supervision; E—Design of Specimens; F—Specifications for Testing Specimens. This program was prepared in page proof form and at a meeting of the Structural Steel Welding Committee, held on April 25, the program was approved. The sections will now be printed and suitable assignments made to companies throughout the United States and Canada.

Although the American Institute of Steel Construction had sent a check in the fall of 1927, covering its contribution for one year, checks from other contributors were not received until March, 1928. This delayed the work somewhat.

The steel for the investigational work has been pledged by the United States Steel Corporation and the Bethlehem Steel Company. About forty leading fabricating shops in the United States have indicated their willingness to participate in the program by making up specimens. A number of university laboratories and the Bureau of Standards have also indicated their willingness to do the testing work. National Research Council is acting as treasurer.

The first step will be to qualify the welders who are to participate in the making up of the test specimens required by the committee.

The funds needed to finance the work have been pledged, and the first year's quota is in hand.

Two More Factory Buildings

Two new factory buildings, all the structural work of which will be arc welded instead of riveted, are now being erected by the General Electric Company. One of these will be an addition to their plant in Bridgeport, Conn., and the other will be located at the company's Pittsfield, Mass., plant.

The first General Electric welded building was erected in Philadelphia, Pa., as an addition to the switchgear manufacturing plant there. This structure, approximately 140 feet wide, 600 feet long and 50 feet high, contains about 1000 tons of welded structural work, and is chiefly notable because of the large number of welded trusses used in the roof structure.

The new building at Bridgeport is to be a small, single-story structure, 64 feet wide and 42 feet long. It will connect two existing buildings in which wire and cable are manufactured, thus making them into one. It will require about 16 tons of steel. The Pittsfield building will be a two-story structure of beam and column construction, about 40 feet wide by 280 feet long, and containing about 250 tons of steel. The building will be of steel frame, brick pilasters, base and cornice and steel sash. Floors and roof will be of concrete. It will be used in the manufacture of molded products.

This company has found that less steel is required in the design of trusses for such buildings, resulting in appreciable savings in cost. Furthermore, the steel is fabricated without the noise of the riveting hammer, and simpler sections can be used.

The trusses in the Bridgeport building are of 64-foot span and are unique in design, utilizing upper and lower chord sections, each consisting

of half of a rolled I-beam. This beam is split in half by the use of a torch and, because of the large amount of web left, the single-angle web members can be directly welded to the web of the chord members.

Fabrication of the trusses and other complete members will be done by the American Bridge Company in its Trenton, N. J., plant, where the trusses for the Philadelphia building were also constructed. This company has devoted an entire building to the work of fabrication of structural shapes by welding.

Construction of the two new buildings is under way. It is expected that both will be completed and ready for occupancy before fall.

Revision of Conditions Under Which the Samuel Wylie Miller Medal Is Awarded by the American Welding Society

The Board of Trustees of the Samuel Wylie Miller Medal, which has been established by Past President Miller, had no paper submitted to it during the calendar year 1927 of sufficient value to merit the award for that year. The Board has, therefore, revised the conditions under which the medal may be awarded as follows:

1. The medal may be awarded annually for any meritorious achievement which, in the judgment of the Board of Trustees, has contributed conspicuously to the advancement of the art of gas fusion welding and cutting or the art of electric arc fusion welding and cutting.

2. The award for any calendar year shall be announced and the medal, together with a suitable certificate, presented at an annual meeting or a fall meeting of the Society as the Board of Trustees may elect.

The conditions governing the award of this medal have been made very broad so that it can be granted for an achievement of any character which has contributed conspicuously to the advancement of either of the two branches of the welding art which are specifically mentioned. Thus, the award may be made for a meritorious paper or an invention or a conspicuous application of welding in industry which has advanced the art either on account of unique technical features or important economic advantages. The award may even be made for conspicuous service of a non-technical character which distinctly advances the welding art.

Welded Steel—Gains and Losses

(Taken from May 10 issue of "The Iron Age")

This growing vogue of welding is causing mixed feelings in the iron and steel industry. Foundrymen may view with concern the supplanting of a sizable quantity of gray iron or large steel castings with built up pieces made of rolled steel; at the same time sellers of the latter product may hail it for bringing them a new outlet. Drop forgers may worry when a forged brake lever is redesigned into a piece of tubing and two end fittings, but the makers of seamless tubes of all sorts regard the rise of the art of welding as a leading factor in the later expansion of their business. Sheet steel has been used in much additional tonnage for automobile bodies and parts, tankage, furniture and architectural details solely because the welded joint has made it adaptable for those purposes.

It is a case of gains offsetting losses; for welding has enabled steel to invade fields formerly held exclusively by other materials of construction, notably wood. Testimony to the same effect was given at the American Welding Society's meeting, just past—that it would help regain some of that large market lost to reinforced concrete.

Before an audience containing many engineers and fabricators, G. A. Caldwell, vice-president Mississippi Valley Structural Steel Co., said that welded structural steel was enabling his company to compete far more successfully with reinforced concrete in that intermediate zone where the advantages of the two systems overlap. He believes that welding, especially when specialized automatic machinery shall have been developed, will so lower the costs of shop fabrication that this midway zone will be pushed over considerably toward the concrete side, with a corresponding improvement in the economic position of those structural shops which specialize in medium heavy buildings.

This development would be gratifying to many branches of the steel trade, though it may bring regret to those who now make and sell steel reinforcement. But here again the net result would be an expansion in steel consumption, since a welded steel structure, even though it may contain somewhat less metal than a riveted equivalent, still uses many times as much steel as the concrete reinforcement in a substitute building.

HONOR LIST

(In securing new members)

William Spraragen	7—B
	1—C
	1—F
J. H. Edwards	1—B
	8—C
A. F. Davis	1—B
	2—C
	1—D
George C. Dierking	3—C
	1—D
Stuart Plumley	3—C
C. M. Rusk	1—B
	1—C
R. C. Crouch	1—B
	1—C
H. W. Saunders	1—C
	2—D
H. Dyar	1—B
T. C. Fetherston	1—B
D. S. Lloyd	1—B
J. G. Ritter	1—B
Charles Schenck	1—B
A. G. Bissell	1—C
A. F. Keogh	1—C
E. R. Lasher	1—C
C. A. McCune	1—C
M. A. Thompson	1—C
W. R. Garten	1—D
W. M. Griffith	1—D
C. W. Hopp	1—D
G. C. Parberry	1—D
G. W. Swan	1—D
B. L. Whaley	1—D
T. A. Wry	1—D

NEW MEMBERS

For the Months of January, February, March and April

BOSTON

Class C

H. C. Wills, Boston Representative, Joseph T. Ryerson & Son, 675 Concord Avenue, Cambridge, Mass.

Class D

E. P. McDermott, Electrician Help, N. Y. N. H. & Hartford R. R. Co., (res.) 48 Gordon St., W. Somerville, Mass.

CANADIAN

Class B

N. W. Taylor, Quebec Representative, Dominion Oxygen Company, Ltd., 225 Bourgeois Street, Montreal, Canada.

Class C

E. T. Bridges, Managing Director, McGregor-McIntyre Structural Steel Co., Ltd., 1139 Shaw Street, Toronto, Canada.

CHICAGO

Class B

L. J. Schanz, Engineering Department, Krembs & Company, 669 West Ohio Street, Chicago, Ill.

Ira B. Yates, Sales Engineer, Joseph T. Ryerson & Son Inc., 16th and Rockwell Sts., Chicago, Ill.

Class C

F. W. Dencer, Plant Engineer, American Bridge Company, Gary, Ind.

J. Fletcher Harper, Engineer, Allis Chalmers Mfg. Company, Milwaukee, Wis.

G. E. Matters, Supervisor, Allis Chalmers Mfg. Company, Milwaukee, Wis.

Albert Reichmann, Division Engineer, American Bridge Company, 208 So. La Salle St., Chicago, Ill.

Otto C. Voss, Superintendent, Allis Chalmers Mfg. Company, Milwaukee, Wis.

Class D

Arthur H. Friese, Lincoln Electric Company, (res.) 1154 41st Street, Milwaukee, Wis.

CLEVELAND

Class B

Albert E. Abbott, Service Operator, The Linde Air Products Company, 628 Keith Bldg., Cleveland, Ohio.

John H. Baker, Welding Superintendent, the Youngstown Sheet & Tube Company, (res.) 225 Scott Street, Youngstown, Ohio.

H. A. Stringfellow, Manager Pipe Division, the Biggs Boiler Works Company, 1007 Bank Street, Akron, Ohio.

Class C

J. S. Adelson, Metallurgical Engineer, Steel and Tubes, Incorporated, 224

East 131st Street, Cleveland, Ohio.
R. K. Randall, Owner, Cleveland Welding School, 2094 East 19th Street, Cleveland, Ohio.

Class D

R. P. Tarbell, District Manager, the Lincoln Electric Company, Box 683, Cleveland, Ohio.

DETROIT

Class C

John Crigger, Foreman, Ford Motor Co. of Canada, (res.) 4450 Burnt Avenue, Detroit, Mich.

NEW YORK

Class B

Robert W. Boggs, Technical Publicity, Union Carbide Company, 30 East 42nd Street, New York City.
Thos. E. Brown, Jr., Consulting Engr., Associated with Waddell & Hardesty, 150 Broadway, New York City.
Geo. F. Nordenholt, Asst. Engineer, American Car & Foundry Company, 30 Church Street, New York City.
C. W. Obert, Consulting Engineer, Union Carbide & Carbon Research Labs., Thompson Avenue and Manley Street, Long Island City.
John W. Sheffer, Asst. Engineer, American Car & Foundry Company, 30 Church Street, New York City.

Class C

Homer F. Butler, Salesman, Joseph T. Ryerson & Son, Box 484, Jersey City, N. J.
R. R. Graham, Engineer, Trenton Plant, American Bridge Company, Trenton, N. J.
O. E. Hovey, Asst. Chief Engineer, American Bridge Company, 71 Broadway, New York City.
H. M. Priest, Assistant Engineer, American Bridge Company, 30 Church Street, New York City.
R. C. Richter, Welder and Cutter, Curtiss Aeroplane & Motor Company, (res.) 89-29 138th St., Jamaica, L. I.
J. E. Wadsworth, Division Engineer, American Bridge Company, 30 Church Street, New York City.
Fred O. Walls, Salesman, Page Steel & Wire Company, 2629 Grand Central Terminal, New York.

Class D

Henry C. Horsting, Manager, Manufacturer's Welding Company, 154 Berriman Street, Brooklyn, N. Y.

NORTHERN NEW YORK

Class C

F. H. Inman, Foreman, General Electric Company, (res.) 2219 Story Avenue, Schenectady, N. Y.

WESTERN NEW YORK

Class C

H. G. Jackson, Arc Welder, Flesch & Schmitt, Inc., 67 Alexander Street, Rochester, N. Y.

Class D

M. R. Frank, Arc Welder, American Radiator Company, (res.) 304 Grider Street, Buffalo, N. Y.

PHILADELPHIA

Class B

L. P. McAllister, Engineer of Tests, Lukens Steel Company, Coatesville, Pa.
Alan M. Scaife, Vice-President, William B. Scaife & Sons Company, Oakmont, Pa.
Justin G. Smeby, Welding Engineer, Westinghouse Elec. & Mfg. Company, Lester Branch, P. O. Philadelphia, Pa.
Chas. P. Turner, Engineer, Research and Development Dept., Bethlehem Steel Company, Bethlehem, Pa.
H. L. Williams, Asst. Manager, McClintic-Marshall Construction Co., Pottstown, Pa.

Class C

J. Geo. Norton, Salesman, Electric Arc Cutting & Welding Company, (res.) Stratford Court, Lansdowne, Pa.
George B. Pino, Draftsman, American Brown Boveri Electric Corp., (res.) 3335 Spring Garden St., Philadelphia, Pa.

Class C

Frank Tucker, Foreman, Boiler Shop, Vulcan Iron Works, Wilkes Barre, Pa.

Class D

C. T. Hall, Welder, Coatesville Boiler Works, Coatesville, Pa.

PITTSBURGH

Class B

Leslie Allen, Manager, Carnegie Wks., McClintic-Marshall Company, Carnegie, Pa.
P. R. Hawthorne, Welding Engineer, Petroleum Iron Works Co., Sharon, Pa.

Class C

John E. Elliott, Plant Engineer,

American Bridge Company, Ambridge, Pa.
Gustavo Lobo, Jr., Research Engr., Westinghouse Elec. & Mfg. Company Research Dept., East Pittsburgh, Pa.
M. E. Lyons, Inspector of Welding, Williams & Company, 901 Penna. Avenue, N. S., Pittsburgh, Pa.
Philip J. Reich, Division Engineer, American Bridge Company, Frick Bldg., Pittsburgh, Pa.

PORTLAND

Class C

Geo. C. Bukowsky, Salesman, John A. Roebling Sons Company, (res.) 105 East 29th Street, Portland, Ore.
Frank K. Hedges, Salesman, U. S. Steel Products Company, 777 Nicolai Street, Portland, Ore.
E. C. Quirk, Salesman, John A. Roebling Sons Company, 487 Lovejoy Street, Portland, Ore.

Class D

Charles Deane, Acetylene Welder, Steel Tank & Pipe Company, (res.) 8 West Kilpatrick Street, Portland, Ore.
John C. Deines, Cutter, Steel Tank & Pipe Company, (res.) 1408 Mallory Street, Portland, Ore.
A. J. Lytsell, Tin Smith Helper, Crown Willamette Paper Company, 320 So. 3rd Street, Oregon City. Ore.
W. H. Scidmore, Electric Welder, Box 205, Beaverton, Ore.
Wilbur C. Smith, Oiler, Crown Willamette Paper Company, Box 164, Willamette, Ore.

SAN FRANCISCO

Class C

Geo. P. Newton, Welder, Montague Pipe & Steel Company, 1003 3rd Street, San Francisco, Cal.

Class D

C. A. Benson, Acetylene Welder, Berkeley Steel Construction Company, (res.) 400 60th Street, Oakland, Cal.
A. E. Wainscott, Foreman Welder, S. P. R. R., (res.) 1220 Regent Street, Alameda, Cal.

SOCIETY

Class B

Enslo S. Dixon, Metallurgist, The Texas Company, Box 712, Port Arthur, Tex.
W. A. Duerr, Manager, The Cabot Company, Box 1075, Pampa, Tex.
Frank B. Floyd, Structural Engineer, Smith & Caffrey Company, 2613 Lodi Street, Syracuse, N. Y.
Harold H. Judson, Welding Advisor, Goulds Pumps, Inc., Seneca Falls, N. Y.
W. W. Williams, President, Williams Bridge Company, 514 Union Bldg., Syracuse, N. Y.

Class C

T. S. Gilpin, Welding Engineer, Marland Refining Company, Ponca City, Okla.
T. Scolari, Data & Information Bureau, Companie Generale di Electtricita, Via Borgognone 34, Milan (124) Italy.
S. C. Toth, Welder Foreman, Skinner Bros. Mfg. Company, (res.) 1223a Geyer Avenue, St. Louis, Mo.
A. Van Craen, Engineer, "Electrodit," Rue G. Gillekens, Vilvorde, Belgium.

Class D

Wm. Hamlet, Foreman Welder, Sutton Garten Company, 217 W. 10th Street, Indianapolis, Ind.
Robt. C. Strange, Electric Welder, A. B. & C. Railway Company, 810 So. Lee Street, Fitzgerald, Ga.

Class F

Paul Ross, Maintenance, Gates Rubber Company, (res.) 1133 Lincoln Street, Denver, Colo.
R. C. Wright, Student, Welding Class, Opportunity School, (res.) 1225 12th Street, Denver, Colo.

SECTION ACTIVITIES

Chicago

This Section held a very interesting meeting on May 18. A unique feature of this meeting was that no one had been assigned as "speaker" for the evening. Several men discussed the subject "Welding Pipe in Industrial and Office Buildings."

Cleveland

On May 31 the Cleveland Section held one of its largest meetings. Mr. Joseph Matte, Jr., of the Albert Kahn, Inc., Architects and Engineers, Detroit, gave some very interesting remarks about welding in the structural field.

Keen interest was displayed in Mr. Matte's talk on the use of arc welding in the fabrication and erection of structural steel. Mr. Matte predicted a promising future for arc welding in the structural field due to the fact that steel frame work could be erected more quickly and quietly and at lower cost by the new method.

Mr. E. E. J. Summers, Chief Contracting Engineer of the H. K. Ferguson Company, in his speech expressed the general contractor's and engineer's view of the approaching new era of steel building construction.

Cleveland Commissioner of Buildings W. D. Guion stressed the urgent need for handbooks on arc welded construction so that building codes may be intelligently compiled to include the new method of construction. A brief talk was also delivered by Mr. C. W. Schubert, Engineer in the City of Cleveland Building Inspection Department. Mr. J. F. Lincoln stated in his address on "Arc Welding in Structural Work" that welding is now where riveting was twenty years ago in regard to costs, but from present indications there is every reason to believe that it will surpass riveting in five years.

Los Angeles

The June meeting of this Section was held on June 6. Mr. F. G. Harmon, Field Service Engineer, National Tube Company, was the speaker at this meeting. Mr. A. E. DeBurn showed a picture entitled "Arteries of Industry."

Philadelphia

The Philadelphia Section meeting on Monday evening, May 21, was well attended. Mr. Catlett of the General Electric Company gave a demonstration and lecture on atomic hydrogen welding. The next meeting of this Section will be in September.

Northern New York

The Northern New York Section held a meeting on May 10 at the Pittsfield Works of the General Electric Company. At 2.30 p. m. an inspection trip was made through the works to see the different applications of welding processes. This trip was under the direction of Messrs. R. E. Wagner, H. W. Tobey and J. H. Martin of the Pittsfield Works.

The meeting was held at 7.30 in the Works Auditorium. Prof. F. P. McKibben gave an illustrated talk on structural steel welding, including the application of welding to the new building erected at the Philadelphia Works of the General Electric Company. Professor McKibben also gave illustrations of the methods of design of welded girders as compared with riveted girders. He also spoke of the importance of the elimination of noise in the erection of steel structures by the use of welding processes.

Mr. W. L. Warner of the General Electric Company gave a talk on pressure vessels.

Two new General Electric moving picture films were shown. The first of these films, "Welding a Pipe Line," shows the forming and welding of pipe section by the Walsh's Holyoke Steam Boiler Works for a new pipe line for the City of Springfield, Mass. These pipe sections are 36 feet long and are welded on a rigid beam seam welder with four automatic welding heads.

The second film was "Automatic Arc Welding," and shows the application of automatic welders in a large number of ways.

The following officers were elected for 1928-29:

Chairman—J. D. Wright, General Electric Co., Schenectady, N. Y.

First Vice-Chairman—H. W. Tobey, General Electric Company, Pittsfield, Mass.

Second Vice-Chairman—L. R. Beers, General Electric Company, Schenectady, N. Y.

Secretary—F. M. Jefts, General Electric Company, Schenectady, N. Y.

Treasurer—T. T. Gillette, General Electric Company, Schenectady, N. Y.

Directors—J. H. Martin, A. Vogel, L. R. Beers, V. J. Chapman, E. J. O'Connell, W. P. Madden.

Director at Large—D. H. Deyoe.

San Francisco

The May meeting of this Section was held as a joint meeting with the American Society for Steel Treating on Wednesday, May 9. There were three short talks by Messrs. J. V. Coulter, S. H. Edwards and Ivan L. Johnson, members of the A.S.S.T. After this K. V. Laird, member of the A.W.S., gave an illustrated talk on "Some Metallographic Aspects of Welds Subjected to High Temperatures."

Western New York

The Annual Meeting and Election of Officers of the Western New York Sec-

tion was held on May 25. Prof. E. P. McKibben, Consulting Engineer for the General Electric Company, spoke on "General Electric Company's 1000-Ton Electrically Welded Building at West Philadelphia."

The following officers were elected for the year 1928-29:

Chairman—Mr. F. L. Rodgers, District Sales Manager, Linde Air Products Company, Buffalo, N. Y.

Vice-Chairman—Mr. E. S. Hebeler, Vice-President, Allan Mfg. & Welding Co., Buffalo, N. Y.

Secretary and Treasurer—Mr. G. W. Swan, John A. Roebling's Sons Co. of New York, Buffalo, N. Y.

Chairman, Papers and Meetings Committee—Mr. Robert Seimer, President, Allan Mfg. & Welding Co., Buffalo, N. Y.

Chairman, Membership Committee—Mr. R. W. Bannar, Manager Welding Sales, Root Neal & Company, Buffalo, N. Y.

Chairman, By-Laws Committee—Mr. C. H. Lockwood, General Electric Co., Buffalo, N. Y.

Representative to the A.W.S.—Mr. Robert Siemer, President, Allan Mfg. & Welding Co., Buffalo, N. Y.

New York

An exceedingly interesting meeting of the New York Section was held on May 15. Mr. W. R. Hulbert of the Metal & Thermit Corporation presented an illustrated review of the "New Developments in Reclamation Work with Thermit." He was followed by Mr. J. F. Lincoln, vice-president of the Lincoln Electric Company, who described in detail the "Electronic Tornado" process of carbon arc welding. Mr. Lincoln's lecture was also illustrated by lantern slides.

The Nominating Committee, consisting of the following personnel, F. E. Rogers, Chairman, E. H. Ewertz, A. E. Gaynor, A. G. Oehler, W. Spraragen, was elected to nominate officers for the ensuing year.

EMPLOYMENT SERVICE BULLETIN

Opportunities.—The Society is glad to learn of desirable opportunities from responsible sources, announcements of which will be published without charge in the BULLETIN.

Services Available.—Under this heading brief announcements (not more than seventy-five words in length) will be published without charge to members. Announcements will not be repeated except upon request received after an interval of three months; during this period, names and records will remain in the office reference files.

Note.—Copy for publication in the BULLETIN should reach the Society's Office not later than the thirtieth of the month if publication in the following issue is desired. *ALL REPLIES should be addressed to the number indicated in each case and mailed to Society headquarters.*

SERVICES AVAILABLE

A-75. Welder desires position. Have had a number of years' experience, including two years with American Locomotive Company, welding and cutting. Welding for Kaustine Company, ten months. Welding for M. C. R., two years. Welding at Kellogs and Kovens, Jersey City.

A-76. Welder desires position. Have had ten years' experience in gas and arc welding in steel mills, steel foundries, repair shop, and pressure pipe welding. Am willing to go anywhere.

A-77. Welder desires position. Am capable of doing any class of welding. Would prefer foreign work.

A-78. Executive and Salesman desires position. Can organize and handle men. Desirous of making connection with a live going concern. Have had successful experience handling the sales of alloys, castings, finished products, particularly for resistance welding. Can furnish excellent reference as to ability, honesty and character. Have a wide acquaintance among executives and purchasing agents. Am 38 years of age and am married. Have a college as well as a technical education.

Discussion of Technical Papers Presented at Annual Meeting of American Welding Society

Discussion paper on Welding Corrosion Resisting Steel Alloys* by Mr. W. B. Miller of the Union Carbide and Carbon Research Laboratories.

Mr. A. M. Candy, Westinghouse Elec. & Mfg. Co.: Mr. Miller has certainly presented a very interesting paper and I am sorry, as Mr. Farmer said, it wasn't in print so we could have had a chance to absorb some of it beforehand. There are just two questions I would like to ask Mr. Miller and one of them may be taking some words out of Mr. Burkhart's mouth, and if it is, maybe we can draw him out in the discussion.

The first question I have in mind is relative to the statement Mr. Miller made about the silicon content improving the welding quality of some of these corrosion-resisting steels. I would like to know why the silicon content influences that materially.

The other question that I would like to raise is whether or not Mr. Miller has had experience welding some of the corrosion-resisting steels such as resistol steel which, I believe, contains about 0.20 to 0.30 per cent carbon and somewhere around 12 or 14 per cent chromium to ordinary boiler plate. That brings in a question Mr. Burkhart will be interested in.

Mr. W. B. Miller, Union Carbide & Carbon Res. Labs.: Silicon makes a metal flow a little more sluggishly. It keeps it from boiling and you get an oxidation of silicon during welding which gives a light blanket of slag, and if you don't use too much heat you can get very quiet fusion and welding is not difficult. It also assures a denser weld metal. Furthermore, a high silicon content anywhere up to a half or seven-tenths of a per cent is incidental to the method of manufacture, for it appears to be easier to make the chromium alloys with not less than three-tenths silicon.

Resistol is a trade name used by one of the large companies. There are several resistols. They are low-carbon, high-nickel alloys, the chromium varying from 8 to 25 per cent, nickel 17 to 22 per cent. I wouldn't recommend welding any chromium alloy with low-carbon steel if there is any stress or vibration, because somewhere in that joint there will be a zone of low-chromium content and this zone is very brittle.

Mr. L. H. Burkhart, Struthers-Wells Company: I seem to have been drawn into this discussion by Mr. Candy. We had a lot of information on test specimens which are prepared of thin plate, none of which is very applicable to commercial use. In commercial work you are deal-

*Paper published in May, 1927 issue, Journal of the A. W. S.

ing with large units, large vessels and thicker plate and annealing is impossible except probably a little torch annealing. You are oftentimes directed in your use of chrome alloy by the users of it and they often say that the presence of nickel, which makes it weldable, is deleterious to the chemical reaction that they desire to carry on in these vessels. Thus nickel-chromium alloys are out of the picture entirely. We must confine ourselves to the use of straight chromium alloys.

The company that I am with at the present time is fabricating several thousand tons of stainless steel, but it is all riveted, for the reason that users of stainless steel are nearly all producers of nitric acid and similar agents where the presence of nickel is deleterious. They claim that a welded joint with slightly different composition from the parent metal will invariably set up electrolysis in the weld, and the weld fails for that reason. As a matter of fact, that point is so essential that they will not permit the use of rivets of slightly different composition in a riveted joint, stating that electrolysis sets up and the rivets dissolve while the parent metal or the plate stands up all right.

I had a little experience myself on that same subject. We built a small 55-gal. drum for nitric acid and in the end of that drum was a spud. We fastened that in with a screw joint. We thought that the material in this spud was the same material as the plate, but in about two months' time this spud was entirely dissolved while the plate of the drum showed no effects whatever of corrosion or electrolysis. We were fooled in the selection of what we thought was the right metal. Somebody imposed upon us. The drum was returned to our plant and we then went very cautiously about selecting the same material, and this time we welded using a gas weld, and as far as I know the drum is in existence today, standing up satisfactorily.

Mr. Candy referred to welding of resistol. I think that was a rezistal number two. That is the lowest rezistal in nickel content that the Crucible Steel Company makes and the problem was to attach terminal bushings for circuit breaker into an open-hearth steel plate cover. We thought at first that this might be done by using open-hearth steel wire and electric welding. Our first effort was a miserable failure. The welds were hard and they cracked and we could not do a thing with them. We cut them out. Then we thought that electric welding was not the right process to use. So we decided to use the gas welding and we found that with gas welding, using a resistol filler rod, we made a very successful weld. The vessel in which this bushing was welded was subjected to 500 lb. pressure and no cracks or signs of failure were present. I understand that further experimental work on this same job has been done. Mr. Candy might be able to tell you more about that than I, but I got it from one of the men of his company. He said that you can take the rezistal with rezistal wire and weld it electrically to resistol and get a satisfactory job. He also said that you could take rezistal wire, rezistal tube and open-hearth steel plate and if you manipulated the welding properly you

would get a good job. By that I understand he means that you must hold the arc mostly on the rezistal because it is of higher melting temperature than the open-hearth plate and allow the molten metal to flow off and over and cut into the steel. This would be an uncertain operation and I doubt very much whether a job would be satisfactory against leaks and pressure by such a procedure.

The experience which we have had leads us to believe that with gas welding, and if it is possible to weld from both sides, that you would get a satisfactory job.

Now, we did not analyze the welds to know whether or not they contained the original composition of chromium or carbon. We weren't so much interested in that as we were to get a strong, tight weld, and that we succeeded fairly well in doing. With a little additional experience which we are now obtaining I think the problem is solved.

We have opportunities to weld stainless steel nearly every day in the week, but we are fighting a little shy of it on large vessels because there is a whole lot to be found out yet before we can say it is a commercial proposition, especially with the electric welding of it. I have an idea that if you take a direct current arc machine and if you can use with that machine the hydrogen arc torch, I think you will probably succeed in solving your problem. Mr. Warner might be able to give us some information along these lines.

Mr. Candy: The only thing I can say, Mr. Chairman, is that the experimental work is now under way in line with what Mr. Burkhart brought out, and we are not in a position to make any additional statements right at the present time, but we probably will later on.

Mr. W. B. Miller: Nitric acid is the easiest thing that chrome alloy has to stand. That is their greatest field of usefulness today. So I can't understand how a plug which Mr. Burkhart mentioned, if it was a straight iron chromium alloy, would be eaten out even by electrolysis. We came up against a proposition in which nitric acid was used and chromium alloys were condemned. We finally got a piece of the metal and found out it wasn't iron chromium at all; it was nickel with 12 per cent chromium—say 60 nickel, 12 chromium and the rest iron. That will not withstand nitric acid under the conditions of this particular test; whereas straight chromium alloy will.

Mr. Burkhart: As I remarked, speaking about this plug, we were imposed upon; I am quite certain of that. I don't think that we had the same material. I believe that it was another metal entirely, although we bought it for the same material. It was for that reason that electrolysis developed.

Nitric acid is about the only acid that does not attack stainless steel. You can take sulphuric or hydrochloric and they will both dissolve the metal at certain rates.

Mr. H. L. Whittemore (Bureau of Standards): There is one phase of this matter which I don't think has been brought out. Most of the applications which have been suggested are for tanks and other heavy structures. We don't want to lose sight of the fact that the aircraft

industry is a big field for the welding of stainless alloys. Of course, we all thought that the aircraft industry was going ahead faster than it has since the war. As I understand it commercial aviation is taking on new life and is increasing at a very rapid rate. This means that in the very near future there is going to be a wide field for metal aircraft structures. I have been working with the Committee on Materials for Aircraft of the National Advisory Committee for Aeronautics. The question has come up a number of times as to whether it was advisable to put a great deal more money into the investigation of wood aircraft structures. It has been rather the opinion that wood was disappearing rapidly and metal construction was taking its place. If you are going to use steel construction, the best way to fabricate it is welding. I believe that welded steel fuselages are used almost exclusively at present. Wood is still used for the wing structure, which is somewhat more heavily loaded.

This Committee on Materials for Aircraft has been urging the steel industry to supply information on welding stainless alloys, and Mr. Miller's paper is a very valuable contribution. I want to request you if you have any information on this subject to contribute it for the benefit of the aircraft industry.

Most of the airplane construction is tubular. In the dirigibles of the Shenandoah class they use girders built up from channel-shaped longitudinals and connect the diagonal lattices by riveting. In compressive tests you can get the fiber stress in the longitudinals up to something like 13,000 lb., much below the yield point of the material because they behave like long columns. We have been making a detailed study of their behavior. We found that when the longitudinals start to fail between the lattices here they twist. If you can restrain the twist you can increase the stress, almost double it. That would apply to their steel structures also. Obviously, the way to resist a twist, one way to resist it, is to use tubes. I was told that the navy would not use tubes because it was impossible to detect corrosion on the inside. They are deathly afraid of corrosion because the stresses are high, the sections are thin and corrosion is very dangerous.

In welding tubular fuselages holes are drilled so as to connect the spaces inside the tubes and oil is pumped through the tubes.

If you can use stainless steels in these structures, you have the problem licked. I want to urge all of you, if you can, to contribute to this use of stainless steel.

Mr. R. A. Weinman, General Electric Company: Since the work we have been doing with chrome-iron alloys involves an entirely different process of welding, I was glad to be called on personally to discuss the results we obtained with atomic hydrogen. Mr. Burkhart probably had this process of welding in mind when he mentioned the electric arc in connection with an atmosphere of hydrogen.

Atomic hydrogen itself is one of the most reducing atmospheres we have available at the present time, and therefore, it does not require an additional flux for the complete fusion of any of the alloys Mr.

Miller illustrated to us. I personally have not made any physical tests on the welds we have made so far, because practically all the objects welded were of a stationary character where very little machine strain was involved. Welded alloys containing from 13 to 15 per cent chromium have been annealed in furnaces by others using about the same process Mr. Miller described in his furnace anneal; where practically all the former ductility was restored to the welded section. We have never, to my knowledge, annealed any of these alloys with the torch.

On tests for corrosion of welds with these alloys, the welds have shown greater attack and agree quite well with Mr. Miller's work. This, however, I think is to be expected since the deposited metal is of less density than rolled material.

The addition of silicon to almost all of the alloys, as Mr. Miller shows, has also improved the welding properties of the metals, especially those containing the higher contents of chromium with the atomic hydrogen process of welding.

Mr. W. B. Miller: Regardless of the method used to melt chromium alloys, certain types are always brittle. It is an inherent property of the metal. It is not anything that is tied up with the process of melting. In other words, some of these alloys when heated up almost to the melting point are made brittle. I think we all have to face that but in certain cases we are able to overcome it by heat treatment.

Mr. J. J. Crowe, Air Reduction Sales Company: I just want to call attention to the fact that in welding plates of these high-chrome alloys it has been our experience that you have to allow just about twice the space for contraction that you do in the carbon steels. We have also observed that, due to the high tensile strength of these resistol steels, you do not obtain the buckling so often present in carbon steels.

Mr. Whittemore: I would like to suggest that Mr. Miller put into his published paper all the details of the bend test, particularly the radius around which the specimens were bent. I didn't hear these values when the paper was given. No measurement was made of the radius at the bend.

Mr. W. B. Miller: We really didn't use any radius. The bends were transverse of the length of the weld. The specimens were pressed in a vise until they showed a crack.

Mr. Whittemore: As I remember it, here is the weld and you put it in a vise and if you got 35 deg. the radius on the inside of the bend is equal to zero.

Mr. Miller: We don't believe in bending specimens that way. This is the jaw vise and we put a piece in here like this. Bending should be produced by squeezing in a vise. This produces a sharp angle and concentrates the stress so that a break occurs much sooner than if you just put it to a compression bend.

Mr. Whittemore: Doesn't the inside radius of the curve vary in different specimens? Some might have an inch radius when you got

30 deg. and some might have a sixteenth of an inch radius when you got 30 deg.

Mr. Miller: It was an eighteen-gage sheet.

Mr. Weinman: That would depend upon the length.

Mr. Whittemore: There is an unmeasured factor in this work which I should think should be taken care of. When you record your 35 deg. you ought to give the radius at the inside of the curve at that point.

Mr. Miller: Those data were not quantitative. They were only comparative. What we were trying to show was that the different types of alloys give different bending results.

Mr. Candy: Mr. Chairman, if I may ask one more question without appearing to talk too much. In reference to Professor Whittemore's discussion of the airplane construction, am I to understand that the airplane engineers are afraid of corrosion even though the tubing is completely sealed by welding so that there can't be any air circulation through the structure?

Mr. Whittemore: I am not directly connected with that work and can't answer from personal experience, but the fact that they pump a protective coating through the frame very carefully and then seal it up would lead to the conclusion that they were afraid of that. It is said that they would not consider using duralumin tubes for the airship girders on that account. Whether it would do any good to put anything in there or not I don't know. They don't want anything they can't inspect all around. If you can use corrosion-resisting alloys, I think they would be open to conviction. The thing is of great importance and will probably have an immense bearing on the future development of aircraft in this country.

Mr. Weinman: I think the corrosion problem that we are speaking of now applies more to duralumin than any other alloy that I have come in contact with. I have done a lot of work on this duralumin, and just as soon as the duralumin alloy was mentioned the corrosion characteristics jumped up very fast. We are at the present time making atmospheric and spray tests for corrosion on duralumin welded under varied conditions.

Mr. S. W. Miller, Union Carbide & Carbon Res. Labs.: I had a very interesting visit to an airplane factory in Canada some time ago. They raised this very question about the corrosion of the various parts of airplanes. Professor Whittemore's statement was borne out in detail by the engineer to whom I talked. They are definitely afraid of corrosion because with the exceedingly light tubing they are using in their fuselages, the very slightest amount of corrosion reduces the factor of safety, which is exceedingly low originally, of the order of two or less in many cases, to such a point that the structure is dangerous.

There one other part of an airplane, of a naval airplane particularly, and that is the pontoons which are usually made out of wood and are exceedingly expensive, because of the thousands of wood screws in them and they are very seriously considering the use of these cor-

rosion-resisting alloys as a substitute. It is obviously very easy to weld together a shell of corrosion-resisting material into a pontoon much more easily and cheaply than it is to make one out of wood. There is only one question and that is the bracing of such a structure to keep it from kinking when it alights on the water. I think that Dr. Whittemore's point is very well taken, and that it is going to be of tremendous benefit in the airplane industry when they get around to using these corrosion-resisting materials.

Mr. Burkhart: Monel metal is a rust-resisting metal and we occasionally have opportunities to weld that. I am wondering if any members have had any experience with it.

Mr. S. W. Miller: Monel metal is very easily welded. You can get a tensile strength in the welded joint of between 45,000 and 50,000 lb., but you mustn't use any flux, otherwise the weld will be porous. I have tried many fluxes on monel metal, but none of them avoided the difficulty of porosity. I have welded plates as thick as half inch and from that down. The action of the flux in the case of monel metal seems to be the cleaning of the surface. If you don't use flux there is a heavy slag on top of it that prevents the access of air to it and consequently, I believe, the absorption of gases by the metal, which being a composition of nickel and copper, is particularly susceptible to solution of gases in the hot metal with resultant porosity.

The International Nickel Company has a very nice pamphlet on the welding of monel metal that may be of some assistance.

Mr. Burkhart: I assume that Mr. Miller referred to gas welding, although the International Nickel Company would advocate carbon arc welding. We recently tried to weld a small pressure vessel of monel metal and our experimental work, previous to the attempting of the vessel, was done on some samples using the gas welding without flux. The results looked encouraging. So we went ahead with the job it was desired to weld from both sides, the outside weld seemed to hold pretty well, but when we attempted to put the weld on the inside the whole thing cracked. We are now attempting to use the carbon arc on the job.

Mr. S. W. Miller: How thick was that material?

Mr. Burkhart: One-quarter and three-sixteenths.

Mr. S. W. Miller: How long was the seam?

Mr. Burkhart: Three feet.

Mr. S. W. Miller: I have successfully welded 4-ft. length of seam, but Mr. Burkhart's statement is perfectly correct and the only way to overcome it is to preheat the weld after the first side is welded. Put underneath it a gas burner that will keep it at a temperature of 600 deg. Fahr. or something like that, and I think you will have no trouble in finishing your weld on the other side.

Mr. Burkhart: This was a vessel with two shells. We couldn't get at both sides.

Mr. S. W. Miller: Obviously, if it can't be done, it can't be done.

Mr. Weinman: Regarding monel metal, we have done considerable welding on monel and I find that a man having quite a little experience with welding will do a whole lot better job than a man who has never been up against it before, particularly so with regard to the amount of heat that he applies to his weld. The metal fuses together very rapidly with atomic hydrogen, and since it absorbs gas in a molten state very rapid work is required. I think that a well-trained operator either on gas, electric, or any other line of application in the welding of that material will show a marked difference on the type of weld that is got.

Mr. W. B. Miller: I would like to add a little word to the monel discussion. Every metal, particularly the more unusual ones, has certain physical properties that must be taken account of in order to assure success. High nickel alloys are quite apt to be red short. In other words, they are brittle and lack strength just after solidification. You have got to take that into account with welding. If you do that it will help solve many of the difficulties. You must take care of the expansion and contraction so as to take stress of just-solidified high-nickel alloys.

President F. M. Farmer: I am sure we all appreciate Mr. Miller's contribution to a very important phase of the welding field, one which is destined to become increasingly important, as has been suggested in much of the discussion.

WRITTEN DISCUSSION

Mr. J. B. Green, Fusion Welding Corp.: My comments are based on some field work but mostly on that done in the research laboratory of our company. We have found that all of the high chromium alloys can be successfully welded by each of the three fusion processes, gas, carbon and metallic arc, provided a "successful weld" be defined as merely a sound, smooth one firmly joining to the parent metal. We feel, however, that such a statement is more apt than not to lead the prospective user to disappointing experiments because cost is the paramount factor in practically all commercial applications. The reader is left by Mr. Miller pretty much to draw his own conclusions as to the significance of cost in connection with this sort of welding. Not only the cost of doing the welding but also the cost of both experimentation and failures must, for the moment, be carefully considered by prospective users.

I appreciate that the significance of cost of welding and cutting high chrome alloys is the subject of a long paper in itself and certainly too much to deal with in a discussion of Mr. Miller's paper more than merely in a suggestive way. Heat treating and preheating equipment for full-sized welded articles is usually very expensive to install and operate, therefore it would seem best at first to direct particular attention to those alloys which do not require these applications. If money

is to be spent, it would seem it should go in the direction of using materials and methods which insure a uniform high quality of work with a minimum of special knowledge on the part both of the supervisor and welder. After a knowledge of welding high chrome alloys is more widely scattered among those applying welding commercially, corners may be trimmed intelligently and safely as applications appear which permit. An epidemic of failures while stainless steel welding is still in its infancy will deprive both those making and using welded articles of much of the value of such alloys to industry.

In the matter of technical facts, Mr. Miller's paper corroborates the findings of our laboratory and I am glad that his work is being made public. I do not take issue with him on what he says but rather on how he says it. I feel that a somewhat more conservative attitude will better serve the welding industry and that the proper impression to leave is that, while all stainless steels can be successfully welded by any one of the three fusion methods, still the subject introduces a great many new variables with which the organization doing mild steel welding are usually not familiar and, furthermore, that much additional information to that contained in Mr. Miller's paper is really required before making the first attempt.

Discussion paper on "Building Up Rail Ends by the Electric Arc Process," by Mr. M. H. Turner of the Electric Rail Weld Service Corporation.

President Farmer: I am informed Mr. Turner will not be here and I am going to ask Mr. Sparagen if he will be good enough to present the paper which is printed in the April issue of the JOURNAL.

Mr. A. G. Oehler, *Railway Age*: It has been some time since I have been in touch with this subject, but I believe some sixty or seventy trunk lines are now welding battered rail ends and I think there are four or five who have employed the electric arc method.

I notice that the paper spoke of reclaiming damaged sections 4 ft. in length. I do not think that those sections were on what I have termed trunk line railroads. I think they were limited to sections which are held in place in pavement. A large part of this work has been done on the Southern Pacific and they have much track of this character. Quite a number of railroads are still averse to doing any of this kind of welding, but those who have have usually come to the conclusion that as long as the welding is limited to the rail ends, well within the fish plates, no damage can result from a possible failure of a battered rail end. It is not used on main lines for the welding of burned driver spots or equivalent.

Mr. Candy: Mr. Chairman, I would like to ask Mr. Sparagen to explain why the cross grinding of rail joint welding prevents compres-

sion fractures. I don't quite see that point and I wonder whether Mr. Spraragen is prepared to answer that.

Mr. W. Spraragen, American Welding Society: I believe the author means that grinding removes the weld so there is a space between the two rails, the same as if they were brand new rails. In hot weather they will expand and close up. Otherwise, if the metal bridged the gap, there would be buckling of rails.

Mr. Crowe: Mr. Spraragen answered that one so well I would like to ask him another one. In the first part of the paper the author implies that he has a method detecting fatigue in the metal. I would like to ask him what that method is.

Mr. Spraragen: I believe they chip and grind away until they get what they think is solid metal.

Mr. Burkhart: Mr. Spraragen is pretty good at answering questions. I am going to ask him one, too. I didn't hear anything in the paper about the quality of wire that was used in making this weld. Possibly it was high manganese wire. Was there anything brought out on that, Mr. Spraragen?

Mr. Spraragen: I asked the author that question especially when I found out he wasn't going to be here, but he hasn't answered it in time. I have anticipated that question.

Mr. Burkhart: I might say, in connection with welding high manganese plates, that I have had a little experience in handling that material. In welding plates with as much as 40 per cent of manganese, very hard plate used in abrasive service, the filler rods were the same material. With the electric arc process it welds beautifully, you quench it with water just as fast as you deposit the metal and then the welds are very soft and ductile.

Mr. E. M. T. Ryder, Third Ave. Railway System: My work has been entirely with electric street surface railroads but, of course, it is somewhat the same problem. In fact, we think that the steam road men have stolen our stuff, because welding was done very extensively on street railroads before it was taken up by the steam roads. Of course we are in a little safer position, because if anything does break, there is no danger of derailing the 20th Century Limited, and it is purely a question of economics rather than safety. Practically all the street railway companies make a practice of building up battered rail ends.

A great many companies attempt to weld manganese steel but with varying results. Most of us get along well enough with it that we keep on, but we don't feel that we have really succeeded in making a first-class job, although it pays to do it for the additional life we get in the manganese plates.

We have never used gas welding and I think it has been very little used for that purpose. Of course, having a trolley wire over each track with a supply of direct current handy, it is a very simple matter if you want to be extravagant enough just to put in some resistance

and use that same direct current, wasting the rest of it in getting it down to the voltage that you want. That was the way originally that the electric railroads began their welding work. Now, of course, it is almost universal to use converters and so save the current.

We on the street railroads probably attempt to go a great deal further than the steam road men because we build up broken pieces, even sometimes as much as 2 in. or more in depth at castings and crossings. Here in New York we had a good illustration of that a few years ago at the intersection of Forty-second Street and Eleventh Avenue, where the steam road crosses the street surface road at grade. We built up as much as 3 or 4 in. of welded metal on top of the broken castings and held it together for several months.

President Farmer: I wonder if there aren't some steam railway men here who can give us a little discussion, critical discussion, perhaps, on the proposal.

Mr. F. T. Llewellyn, U. S. Steel Corp.: It may be of interest to know that the Universal Portland Cement Company has for many years renewed its worn crushing-roll faces by welding.

As regards rails, there are two parts of a rail that in steam railroad service are apt to go first. Primarily come the ends which are the parts covered by this paper. The other part of a rail that is apt to go is the outside of the rail. While the wear of a rail is on the inside, due to the conical surface of the wheel, if you examine any old track you will see that fissures do not start on the inside. They start on the outside. I don't know whether that is true in street railroad work, too, but it can be observed by anybody walking along a steam railroad track that has been in service for some years.

The function of a rail is to carry the load and impact of the locomotives and trains that pass over it. I wonder if we are familiar with the amount of contact surface between a wheel in good condition and the rail. I can tell you the amount of contact surface per wheel that supports the 20th Century Limited going from here to Chicago, as shown by observations made by the late Dr. Dudley. It is smaller than a ten-cent piece. The stresses are highly concentrated. The load is not equally divided over this area. The head of a rail is not flat; it is curved. The contour of the tread of the wheels is not flat; it is conical. Theoretically contact would be at a point. Actually there is temporary compression of both rail and wheel. The maximum intensity of stress must occur near the middle of the area of contact. Careful figures have been made as to the amount of that compression. Laboratory tests on the steel constituting the wheel, or on the cast iron, if it be a cast iron wheel, and on the steel rail, show that the materials are good for about 100,000 lb. per square inch in ultimate strength, and yet observations indicate that near the center of contact area there are points where the pressure is over 200,000 lb., which is twice the amount at which theoretically the metal ought to fail.

What is happening? There is no doubt in my mind but that at the very center of the zone of contact the pressure is of that order, name-

ly, twice the ultimate strength. Why doesn't it give? Why isn't there a failure? Because maximum pressure occurs only over a very small area and is withstood by the tension of a series of restraining rings. The rings act as a series of ties resisting the compression motion and the tension in those circular ties decreases progressively as you get further away. The metal doesn't give because it has nowhere to go; it is bound.

Another question is whether there is not an essential difference between the behaviour of welded material, whether used to make a joint or to renew a rail end, when subjected to dynamic stresses of the kind that affect railroad track, as compared with its value when used in more quiescent fashion.

My attention was recently called to a series of tests made abroad which showed very definitely that results secured in static tests on fusion welded joints have no application whatever when the joint is subjected to serious dynamic stresses.

Mr. G. Lobo, Westinghouse Elec. & Mfg. Co.: I wish to state that the Westinghouse Company is at present undertaking a series of tests on the subject of welds under impact, not of welds only, but also in connection with rails, and I believe that before very long we will have some more definite information to give you on that point.

Mr. Llewellyn: You find there is a real difference?

Mr. Lobo: There is a marked difference. We are starting in in applying that to rails so we may have some specific information later on.

Mr. Crowe: In the gas welding of rail ends, they weld right over the joint and then after they have completed the weld they take a chisel and go down through it and make a slot to take care of their expansion strains in the rail. I have an idea from looking at that cut that that is just a thin grinder used for the same purpose. They go right down through the weld to allow for expansion.

Mr. J. H. Deppeler, Metal & Thermit Corp.: I wanted to ask the electric welding men one question on this building up of rail ends which I am a little doubtful on. In the early days of thermit welding of rail ends we used to put the cast thermit steel right into the joint and that cast thermit steel even though considered for the same Brinell hardness nevertheless would wear differently. It wore down much more rapidly than the rolled steel of the rail. Brinell hardness, apparently, did not indicate the wear resistance.

In this building up of rail ends, as I have understood it, the electric process has always been followed by a hammering operation to cause the cast metal to become a little more dense so as to stand the wear. This process described in the paper simply seems to cover the building up of the metal and the grinding of it to the finished surface and the hammering doesn't take place until the load comes on, in which case the joint would again be low, it seems to me.

Mr. Spraragen: I think that these people claim that the deposited metal is extremely hard, even perhaps harder than the rail and that is why they don't have any unusual wear after they are through.

THURSDAY AFTERNOON SESSION

April 26, 1928

President Farmer: This afternoon session is going to be turned over to our President-Elect, Mr. Llewellyn.

Chairman Llewellyn: The subject of the present session is a "Preliminary Progress Report on Qualification of Welders, Inspection and Supervision." In order that there may be no confusion in our minds it might clarify the situation to carefully distinguish between procedure control as applied to the making of test specimens, which has been discussed in several individual committees, and the more general procedure control which is to apply to actual industrial work.

As I understand it, the reports that we are to have this afternoon are more particularly applicable to the latter. They will cover the general procedure control that it is hoped to recommend to the industry in connection with industrial processes as applied commercially to various forms of welding.

Progress reports will be made by Messrs. Moss and Candy.

Mr. H. H. Moss, Linde Air Products Company: Administration matters are moving so fast with the American Welding Society today that it is quite difficult to write a paper in advance of a scheduled meeting and have it correct in all respects by the time of the meeting. When this paper, which I am privileged to read was being prepared, there existed a Committee on Standards for the Qualification of Construction Welders. Very recently, however, this committee was absorbed into a number of committees under the American Welding Society, which consequently has altered the status of our committee, as brought out in the paper. For today, however, let us assume that the committee still exists.

Discussion Paper on "Qualification of Construction Welders"* by H. H. Moss and A. M. Candy.

Chairman Llewellyn: I am sure the Society is indebted to Mr. Moss for the very full "outline" of the activities to be covered by procedure control. The word "outline" makes one think of what is customary in some of the old countries where a man writes a three-volume treatise and entitles it "Introduction to the Study of the Genus Coleoptera."

I can think of only one branch that was not covered in the outline

*Published in the May 1928, issue of JOURNAL of the A. W. S.

and I don't know whether I am in earnest or joking. No, this is no joke. I failed to hear any suggestion on the part of the committee as to the qualification of the designer. Some years ago doubtless the crying need was for the training of skilled and efficient welders, and that still is important, but if I read the signs correctly the crying need today is for skilled and experienced designers. There is a big difference between making an individual joint that has certain properties and combining such joints in a structure.

The next speaker is Mr. Candy of the Westinghouse Electric & Manufacturing Company.

Mr. Candy: Mr. Farmer this morning stated, I believe, that any criticism of the past administration would be welcome. At that time I didn't see fit to make any remarks, but at this time I want to air a very serious grievance against the previous administration. A number of weeks, possibly a few months, ago, Mr. Moss and myself were appointed as a committee to draw up rules and regulations on the qualification of welders and inspection and supervision. Mr. Moss' name appearing first on the program, naturally he held the chairmanship of that committee.

I expected Mr. Moss to cover the gas welding field and I to cover the arc welding field. I very laboriously prepared a quite extensive paper dealing with that subject. Mr. Moss, I believe, did the same thing. Those papers were sent into headquarters and along toward the latter part of the fiscal year the administration decided those papers wouldn't do at all for this meeting this afternoon, although we didn't know they were to be used for such a meeting. Mr. Moss' paper, he gives me to understand, was turned down the same way. Fortunately for me I happened to be located at quite a distance away in Pittsburgh and Mr. Moss was located very near by and they could get at him and so Mr. Moss was the goat and as a result he prepared the paper which he has just delivered which covered both fields. He covers it very thoroughly, as you will admit. My real grievance is that after this very thorough paper I am expected to say something worthwhile.

I think that the paper as Mr. Moss prepared it (and he deserves entire credit for preparing it) is certainly well worthy of consideration. The qualification of welders and, as Mr. Llewellyn pointed out, the qualification of designers is certainly very important. If welding is to be used, for example, in building construction, qualification procedures and codes must be established so that the city building departments have confidence that when a job is let to a contractor that contractor is thoroughly responsible and can produce the desired results and designs will be sound and the structure will stand without any shadow of a doubt. And so the preparation of the various features which Mr. Moss has outlined are certainly very important. They can't be emphasized too much.

Chairman Llewellyn: I do not know on what ground the papers first submitted by Mr. Candy and Mr. Moss were recommended for modification. If, however, the ground was that Mr. Moss' paper dealt

with the gas process and Mr. Candy's paper dealt with the arc process, the new administration, as far as I am concerned, would take exactly the same action. That is to say, I am strongly in favor of any move that will make the requirements for those two processes, as well as any other suitable processes, as uniform as possible. To distribute to the industry one set of requirements for this process and a different set for that process may mean something to members of this Society. It would mean darned little to the industry except confusion.

We will now have, if you please, a discussion of this subject, first a prepared discussion by several gentlemen who are here. First, I would call on Mr. C. E. Loos of the American Bridge Company, who, I imagine, will speak mostly from the standpoint of structural steel welding. Mr. Loos speaks with authority. He is one of those chaps that actually handles the stuff. I take great pleasure in introducing Mr. Loos.

(EDITOR'S NOTE: Discussion by Mr. Loos printed in the May, 1928, issue of the JOURNAL OF THE A. W. S.)

We are indebted to Mr. Loos for his practical comments on the progress report. Mr. Loos has charge of much of the actual welding that is done at the Ambridge plant of the American Bridge Company, where a few thousand tons of welded material have already been produced. What he says is the result of actual observation.

The phase of structural welding will be further discussed by a member of the Society who has had actual experience both in the design of good-sized welded structures and in the actual handling of the work, Mr. G. A. Caldwell of the Mississippi Valley Structural Steel Company.

Mr. G. A. Caldwell, Mississippi Valley Structural Steel Co.: Mr. Chairman and Members of the Society: I doubt whether you would class my comments as a prepared discussion of the subject, for the reason that I did not receive the report of the Committee until late last night and the only preparation that I have for discussing it has been acquired over a number of years of actual experience in the application of welding to structural steel in a shop engaged in the fabricating of light to medium heavy structures.

I will not comment further on the report of the Committee in a general way. It will be only as I see the report viewed from the angle of a structural fabricator that I speak.

The Chairman of the meeting has indicated that design is a very necessary thing and designers really ought to be qualified for designing work for welding. That comment coincides with my experience. There is a resistance to welding in structural steel. That resistance comes from several causes. One is, here is an industry that has been engaged in fabricating steel by a certain method over a period of years and to change that in a short time is like trying to introduce the metric system against the old English system of numbers. Conservative users of structural steel prefer to follow the old tried methods, the methods on which there is no question, that have been proved by years of ex-

perience. The objection to welding is a hang-over from the past. When you speak of welding to certain old-timers, they recall to their minds the specification against welding in the fabrication of steel in the old days. This electric welding and gas welding is something new to them and their minds do not become adjusted to it at once.

The way welding is introduced into structural steel usually has been and will be, when a fabricating shop secures a job on which welding appears to be the economical way of fabricating, one machine is bought and one welder is applied on that job, and as time goes on and the advantages to be obtained from welding become apparent, other products are welded and gradually a force of welders is built up.

Now, when you have one welder or two welders, the idea of supervision doesn't mean very much, for the reason that it is new to everybody connected with it and to have a supervisor for one or two welders is out of the question. In that case there is no question but what the operators should come up to standard specifications as it is indicated that this committee will recommend, but as the force is increased, supervisors become necessary and desirable.

So that to my mind, when a large number are employed, there might be more than one grade of welders employed in a shop. Pursuing the policy which has been preferred by me in building up a welding force, I prefer to largely train my own. One reason for this is, I consider in a welder that character is one of the essential qualifications; a man who has a sense of responsibility, who feels chagrin if one of his welds fails, and any system of tests that you devise to test the practical qualifications of welders will not tell you the character of the man that you employ. It is only by association with him over a period of years that you determine his character. You hear how he talks, his attitude toward his work and his attitude toward society.

The material out of which welders are made is the shop man of average ability, the man who desires to weld. That is one of the first qualifications of a welder; a man that takes personal pride in accomplishment of that which not everybody can do, a skilled trade, that supplies the want of some of the various trades of the past.

In structural steel we have different classes of work. Some welds are determined by the requirement of strength. Others are determined by other requirements. In some cases the amount of weld put on the joint or seam may be determined by necessity to inclose gases under light pressures and the amount of weld required for that, a continuous seam, is amply sufficient to take care of the strength required in the joint. That is just to illustrate where a man with small experience may be employed, a man that is learning the trade, acquiring practice, may be employed to make such a joint, and under supervision of a competent man a certain percentage of men who are acquiring experience can be used on the type of joints or seams which I have indicated.

There is one point brought out in the report, a point that is frequently overlooked by scientific societies, and that is the amount of

weld per unit of time or the speed with which welding is applied, and this constitutes quite a figure in the application of welding to structural steel as against riveting, to determine which will be used.

In the whole field of construction there is a zone in which structural steel and reinforced concrete compete very strongly as to which material will be used. On one side of this zone structural steel holds the position it has always held, in a class of structures that cannot be made out of concrete. On the other side of this zone concrete has routed out steel and superseded steel largely in construction. Welding has been introduced to lower costs in fabricating steel. That is one of the main arguments for welding. In some structures it will very materially reduce costs and it enables steel to hold its place on the side of the zone where steel is supreme and to widen the zone on the other side toward where concrete is used, simply because of cost.

Welding also introduces the opportunity to devise and put in use on certain structures automatic machinery for fabricating steel, and my firm belief is that it will be largely used on certain classes of members in fabrication in the future. It will materially reduce costs for the reason that automatic machinery does not get tired, does not stop to talk and continues on the job. Automatic machinery, I have noted, has the effect of stimulating hand welders and has a tendency to speed them up also.

Chairman Llewellyn: It seems to me, gentlemen, that these practical experiences are worth a great deal. They are from men who are in competition, who have to do work in competition and they are giving their own actual experience.

I wonder if the meeting would be interested in an occurrence this morning. About the middle of the meeting I received notice that I was wanted. Upon going to the telephone I found that at the other end was the engineer of one of the largest railroads entering the City of New York. This railroad has to make certain changes in an important structure which they wish to make in minimum space while still maintaining operation. They have decided that they wish to do it by welding and they asked for certain technical advice, as to various features involved. This is not an isolated example of the growing interest in structural welding.

So much for the structural steel phase of this question. Another very important phase is pipe welding. The first gentleman to discuss this subject will be Mr. E. E. Shanor, vice-president of the Petroleum Iron Works Company.

(EDITOR'S NOTE: Mr. Shanor's article published in the May, 1928, issue of the JOURNAL OF THE A. W. S.)

Is Mr. Beakley of the Whitlock Coil Pipe Company in the room? The next discussion will be presented by Mr. Beakley.

W. C. Beakley, The Whitlock Coil Pipe Company: When I received the flattering invitation to address the Society with a discussion I

accepted with some hesitation and as the time grew near and I did not have a copy of the report to look over, I felt still more trepidation.

After Mr. Moss' very comprehensive paper was read I decided that I might just as well go home, as far as any good to any one except myself was concerned. The points on which I had tentatively prepared discussion were the same that the committee and Mr. Moss had covered, and Mr. Moss, of course, has covered them much more comprehensively. For that reason I am not going to bore the Society, for which you should be duly thankful, by reading the paper, that I have prepared, verbatim, but simply pick out a few of the high spots.

The company that I represent uses all three methods of welding: oxy-acetylene, electric arc and electric resistance. We feel that they overlap to a comparatively small extent. That is, each type of welding is plainly indicated for a certain class of work. It is only in certain borderline cases that they overlap.

We are using more or less standard methods for qualification of welders, such as, I imagine, most concerns which have had much experience in this business are using. We use a test coupon, a flat butt weld, in the first place, which is simply put in a vice and bent. Then, usually after the welder has had a little practice, we allow him to make a double V butt weld which is sent to a laboratory and tested in the standard manner, in a testing machine. We do not find any particular trouble in getting strengths from fifty to sixty thousand pounds per square inch from good welders. Of course, certain welders up to a certain time in their training will not produce such results. Whereas I will not say that all the coupons break outside the weld, we have a good many of them break in the plate outside of the welding, all such welds, of course, running up very close to 60,000 lb. per square inch.

Most of our work is high-pressure work (running up as high as 4000 lb. per square inch working pressure) and, of course, we find that the tensile test does not, by any means, tell the whole story. A welder may make a very acceptable specimen weld, and, at the same time, we find that we have to train him and perfect him very carefully before we can be sure of not only strong welds but welds absolutely tight against pressure. We, of course, agree that the matter of supervision is of extreme importance. Men are carefully supervised, all the way through, and supervisions and inspection are closely linked—one merges into the other.

Mr. Llewellyn's remark about qualification of designers was very well taken. That, perhaps, is just as important a problem as qualification of welders, and particularly, we think, in designing reinforcements, for the different points, in a welded pressure vessel, which are fundamentally weak—that is, such as where a large nozzle is attached to a pressure vessel. One of the things we feel about that (I do not know how generally this is accepted) is that such reinforcements should be welded into actual contact with the body or bodies that they are supposed to reinforce, through as much of the length, depth

and breadth (as the case may be) of the reinforcement as is practical. That is, a wide reinforcement is of rather questionable value, where it is only welded at the edges or ends. So that we favor comparatively chunky reinforcements, on which, using a fairly wide chamfer, we can get fairly well down, along the contact face, and weld practically the whole contact face of the reinforcing ring, or pad, to the part being reinforced.

The subject of the final pressure test is, of course, very important, on all pressure vessels. It is our practice to use from two to three times working pressure, for the hydrostatic test, and then a lower pressure, about 150 per cent of the working pressure, for an air test, where that is required. We use the hammer test on practically all welded work except, of course, there are some cases where it is not practicable, usually applying the hammer test at twice the working pressure for which the unit is built, and then, after it has been thoroughly tested, carrying the pressure, up to two and a half or three times the working pressure, for the final test.

Each test, the hydrostatic test and the air test, are kept on for a minimum period of fifteen or twenty minutes and, of course, the maximum period may run up to an hour, or even longer, depending on how complicated the piece of apparatus is, and how long it takes to complete the necessary inspection of all parts, etc.

I think those are about the only points of interest of which I can think just now that have not already been covered.

Chairman Llewellyn: There is a feature that doubtless is familiar to everybody here but which should be emphasized in distinguishing between the experience of those men who have had to do with structural steel welding and those who more particularly have had to do with pipe and pressure vessel welding; namely, the form of joint. It seems to be a growing experience that the joint that is to be used perhaps 99 per cent in welded structural steel work is the fillet and, of course, we know the joint that is used very largely in pipe and pressure vessel work is the butt weld. In the qualification of welders for structural work however a butt weld coupon is contemplated. There are several reasons for that. One is that we have yet to see a design of a test specimen using fillet welds which when pulled does not induce some bending in the base metal. I have spent hours in trying to design such a test specimen. I have not succeeded and have never seen one. The amount of bending varies under different conditions, but it is always there.

Leaving now pipe welding we come to the subject of pressure vessels. Mr. A. O. Miller, Vice President of Reeves Brothers, will be the first to discuss this phase.

(EDITOR'S NOTE: Mr. Miller's paper was published in the April, 1928, issue of the JOURNAL OF THE A. W. S.)

To me, one of the most interesting features of Mr. Miller's paper is its bearing on the subject we were discussing this morning; namely, the strength of welds under dynamic stress. While not perhaps strictly

dynamic, there were two of his illustrations, the kiln and the vessel containing tracks, that must be subject to considerable impact, and the fact that the weld stands up efficiently under such service is, I think, very satisfactory.

Mr. L. H. Burkhart, Chief Engineer of the Struthers-Wells Company, will discuss this phase further.

Mr. Burkhart: When I received an invitation from Mr. Spraragen to discuss qualification for welders in regard to pressure vessels, I made up my mind that it would be just an oral discussion from the floor and what I would say would depend upon what had been said. Later on I received an appointment on one of the sub-committees to prepare a code for the American Welding Society. So I set about drafting a form for a code which I have with me, and the contents of this code so nearly parallels Mr. Shanor's paper in practice that I am going to give you the parallelisms as I come across them.

Mr. Shanor represents one company and I represent another. We are in no wise connected. We don't visit each other very often. I have been in their shop, but not since they started welding, and I don't know that he has ever been in our shop, but we are doing similar work and the fact that we have arrived at the same way of doing it and the same results, I think, is something almost marvelous. I can cover those points by simply reviewing some of the paragraphs that I have written in this code.

The paper was entitled "Code for Manufacture by Fusion Welding of Pressure Vessels." Under the first item of design, I want to emphasize what our Chairman, Mr. Llewellyn, has said about designers. I believe there are more poor designers working on welded work than there are poor welders. I run across it every day and I am surprised that welded work has stood up as well as it has under a great many very poor designs.

Mr. Burkhart read from his paper beginning, "The design of a pressure vessel must be adequate, etc."...

Chairman Llewellyn: It seems indeed remarkable and more than a coincidence that two concerns working independently like the Petroleum Iron Works and Struthers-Wells Company have come to such similar conclusions. The only points of difference that I happened to note were as to the use of the double V and as to the non-use of hammering. Who was it said that "great minds think alike"?

That concludes the prepared discussions. The meeting is now open for general discussion or questions. There is a half hour before five o'clock and we can stay a little longer perhaps if necessary. I hope there will be prompt discussion because we all have experienced heart-burning at not having said what we really were ready to say and wanted to say because we were just a little bit modest.

Mr. O. C. Tennant, Dominion Bridge Company: There is a question in connection with the design of welding of structural steel that still bothers me. I thought perhaps there would be some light thrown on

it and perhaps there has been. I am sorry I haven't been present at the entire meeting. There have been tests shown of, usually, welds of flats or plates. In a structural steel truss the members are not composed usually of flats or plates, but frequently of two angles.

Let's suppose that we have a member composed of two 4 x 3 angles, one on each side of a gusset plate. We want to weld that on. We will suppose there is a stress of 50,000 lb. in the two angles and that we have standardized on five-sixteenths fillet welds. Assuming a value of 2500 lb. per lin. in. we would require twenty lineal inches of weld. Now at first we might think of putting five inches of weld on each side of each angle on both sides of the plate. That is, put five inches at the root of the angle and five inches at the toe of the angle, but then on consideration that wouldn't be really right, because the center of gravity of that angle we will say is one inch from the back of it, and because it is one inch from the back there should be three times as much strength of weld at the root of the angle as there should be at the toe.

I am just a little in doubt as to what is the best way to design that joint. Is it reasonable to call for a heavier weld at the root of the angle than at the toe or should we call for more lineal inches at the root of the angle than at the toe, or perhaps it would be more reasonable to change the design of the member and make it 4 x 3 Tees. I presume there are some gentlemen here who have been up against just that proposition in roof trusses, for instance, and I would like to know what is the best way to design that joint. I am not quite sure.

Chairman Llewellyn: I believe there are several men here who have had experience on the very point raised by Mr. Tennant, but before asking them to answer I would like to put a question to Mr. Tennant: How do you handle the same situation when you use a riveted construction?

Mr. Tennant: Put a lock angle on the back of the angle.

Chairman Llewellyn: Always?

Mr. Tennant: Not always, but when we don't put it there, we try to feel reasonably sure that any bending that is introduced into the angle will not be serious. We may have an excess of strength in the angle to resist that bending.

Chairman Llewellyn: I believe the question that is raised by Mr. Tennant has been encountered and met by a change in the design, the stresses being very close to the figures that Mr. Tennant mentioned.

Mr. Edwards, I believe you have had recent experience on that point. May we hear from you?

Mr. J. H. Edwards, American Bridge Co.: I don't think the question of meeting the situation is much different than it is in riveted construction. Naturally, the way to do would be to put the amount of welding so that it would be in the center of gravity of the metal as far as you could. On the other hand, we have always tried to meet

the general specifications which you will find in all designs to keep members symmetrical wherever you can.

Chairman Llewellyn: Supplementing Mr. Edwards' remarks, I think if Mr. Tennant will refer to the current issue of the JOURNAL OF THE AMERICAN WELDING SOCIETY, of which copies were on the table outside and are being mailed right now, he will find an article by Prof. McKibben describing almost exactly the situation that he refers to.

Mr. Tennant: I merely asked the question because I knew it was sure to have been considered by someone else who had been designing these things and I was interested to know how it had been met. I couldn't think of any other way than the ways I have outlined.

Chairman Llewellyn: Somewhat lighter stresses than the ones Mr. Tennant refers to were encountered in a number of trusses built at Buffalo a couple of years ago and tested. Perhaps Mr. Moss would tell us exactly how that feature was covered there.

Mr. Moss: Mr. Chairman, in preparing the details for the welded trusses that Mr. Llewellyn referred to, which were developed by The Linde Air Products Company, we utilized a principle that was termed INSERT PLATE CONSTRUCTION. These trusses were developed by the aid of oxy-acetylene butt welding and it was found by a number of detailed laboratory experiments that we could adequately transfer the stresses in both tension and compression members by inserting a gusset plate into the vertical legs of such members. The joint designs departed radically from those customarily used in roof truss construction and I am not certain that the detail is of interest to the gentleman who is probably using electric fillet welding. The designs of the joints resemble in many respects a stamping in that all metal at a joint was continuous. The destructive tests on these joints failed to disclose any discrepancies in the design assumptions from the standpoint of stress transfer. Six trusses in all were tested, one a riveted truss and one of tubular members utilizing a modification of the insert plate principle. In each case, starting from the first, we were able to reduce metal without sacrificing truss strength. The last test case made up of angles and insert plates, utilized about 22 per cent less steel than the riveted truss designed for the same service and had a 10 per cent higher general strength. There was every indication that we could carry out in practice the insert plate principle right down to the theoretical point. This is about all I have to say on this subject, except that it was interesting to witness the results and behavior of the trusses under test, which were very consistent and satisfactory throughout, especially considering the various things we did in that series of tests.

Chairman Llewellyn: Is there any one else who would like to speak to that point regarding the detail of structural steel practice?

If not, general discussion on any of the features that have been raised will be in order.

I would like to ask Mr. Shanor up to what thickness he uses the single V form of butt joint.

Mr. E. E. Shanor, Petroleum Iron Works Company: We would use a single V on any thickness up to 3 or 4 in., whatever you may want to weld. I would make the sides parallel or slightly sloping down nearly to the bottom of the joint.

Mr. Candy: I would like to refer to both Mr. Shanor's paper and the discussion given by Mr. Burkhart relative to the importance of peening weld metal as it is put into a heavy section. This not only, I feel, applies to pressure vessel work, but applies to any structure where we have large, heavy members which have to be joined, and the reason I am mentioning this is because those of you who are interested in structural welding, if you have occasion to use heavy sections requiring butt joints, must observe certain precautions to prevent excessive cooling strains. Just what all the precautions are I shan't pretend to say, maybe Mr. Shanor can give us some help on that, but we certainly have got to watch the stresses that are set up in large, heavy sections, as illustrated by a small crack in one of the large bottom cord members of the Chicopee Falls bridge, about which you have all heard.

So the point Mr. Shanor brought out is something that all structural designers will have to take into consideration where they are getting into heavy butt-type joints. In lap joints, where we are using fillets, that is apparently a different situation. So I would like to ask Mr. Shanor directly as to what thickness of section his experience would indicate it is necessary to start the peening operation to relieve the stresses?

Mr. Shanor: Everybody knows that a shop superintendent is always anxious to turn his work out at the least possible cost. Peening will add possibly one-third to the labor cost of welding.

Just before I left our plant I asked our shop superintendent what he thought about peening. He stated that he had thought it was not necessary to peen on less important work. He told me that he had just finished a job on which he had omitted the peening as he thought it unnecessary. Under test several little leaks developed which it was necessary to chip out and re-weld. Consequently he instructed his foreman to carefully peen the next similar job going through, which was perfect under test. He is firmly convinced that peening is advisable on any job as a result of several experiences of this kind.

In welding a ⅜-in. plate we would probably make two passes on the outside. The first pass would be peened. One object of peening is to relieve the heat stresses and if you peen a job you can be fairly certain that the weld will not crack.

Consider welding a 4-in. plate by the layer method without peening. Not infrequently contractual stresses will break that plate as though it were cardboard. If you peen a weld carefully as it is made there will be no trouble with contractual stresses.

Chairman Llewellyn: I understand that you would recommend peening any work that consists of more than one layer?

Mr. Shanor: Yes.

Chairman Llewellyn: But not a single layer?

Mr. Shanor: We have not been peening single layer joints. Peening relieves heat strains and also cleans the scale and slag and dirt away for succeeding layers. It is important that you do not have slag and dirt in the weld.

Comparing welding to riveted work, you can estimate a single riveted joint, say 50 per cent efficient, and you can consider a double riveted joint 70 per cent efficient, and a triple riveted joint 80 per cent. You can tell what you are going to get, but with a welded joint you cannot tell what you are going to get if you tell a welder that you do not need a good job. For that reason it is important to get 100 per cent efficiency all the time.

Chairman Llewellyn: You think it is a case of the grocer who offered eggs that were nearly fresh.

Mr. J. D. Wright, General Electric Company: In discussing qualifications of welder, I think Mr. Shanor mentioned that he required that coupons break outside the weld in every case. I would like to inquire if in those cases the reinforcement is ground off.

Mr. Shanor: In general we do not grind the reinforcing off, but we have ground it off in many tests. When you are pulling a welded test specimen the yield point in the weld is considerably higher than the yield point in the base metal. For that reason the base metal will start to neck and thin out before the yield point has been reached in the welded metal. For this reason the break will generally occur in the base metal and this is not a certain indication that the ultimate strength in the weld is higher than in the base metal. However, a proper weld with the reinforcing ground off should break outside of the weld.

Mr. Burkhart: I would like to ask Mr. Shanor one question. He said with a thick plate that he would bevel from one side only, making one angle steeper than the other. I would like to inquire if he encounters more or less unreliability in trying to weld against that steep side compared with the side that has the more slope? It has been my experience that a welder in welding into a V groove will work on both sides about alike. If he has one side nearly perpendicular, he will not touch that side with his electrode if he is using electric welding, as much or as easily as he will the side that has a greater slope, and I think that the weld will not be quite as good as if the slope were the same on both sides. I advocate very strongly welding everything from both sides.

Mr. E. A. Doyle, Linde Air Products Co.: I understood Mr. Loos to say in his talk that in welding structural iron dirt, slag or laminations made no difference in welding, but that in repairs he had to be careful about paint. I would like to know wherein the difference and in just what kind of welding the slag inclusions or laminations make no difference.

Mr. C. E. Loos, American Bridge Company: I believe you misunderstood me in that respect. I meant that it offered no serious problem.

In speaking of dirt, I was referring to internal dirt. I believe that there is no more uniform steel on the market now than the medium open hearth structural grade of steel and that the difficulties encountered in welding that grade of steel are very slight.

In the case of heavy scale and paint that cannot be brushed or scraped off readily, the welder will use (in the case of an electric welder) a $\frac{1}{8}$-in. rod and run it along the place that he is to weld. The scale or paint is loosened by the heat of the arc. The melted electrode cannot be deposited or "burnt in" and is scraped off with the loosened paint or scale.

Going back to the question of laminations, dirt and slag, I think that that is more a problem encountered in welding wrought iron as specified in Mr. Moss' paper. It is not a serious problem in welding structural steel.

Mr. Doyle: I take it, then, that that condition is not found in structural steel and not a condition that would offer serious welding obstacles?

Mr. Loos: It is encountered in wrought iron.

Chairman Llewellyn: As I understand Mr. Loos' answer, he is not of the opinion that the features in question would be harmless if they existed, but he states that in the grade of structural steel that is on the market those conditions do not exist to an extent that may cause trouble.

Mr. J. W. Owens, Newport News Shipbuilding & Dry Dock Co.: In ship construction it is a general practice to paint the contact or faying surfaces of riveted joints with red lead, when, however, it is necessary to weld the edges of such joints, the oil binder is vaporized, causing porosity of the weld. This porosity is usually observed when tanks and bulkheads are hydrostatically tested, with the result that many inspectors obtain the impression that welds are necessarily porous.

I discussed the matter yesterday with Mr. David Arnott, Chief Surveyor for the American Bureau of Shipping, and he stated that he would approve the elimination of paint between the surfaces of riveted joints. I also discussed the question some time ago with the Bureau of Construction and Repair of the Navy and was informed that experience had shown that after a few years the red lead had disappeared from between the joint surfaces. Again, during 1926, I made a test to determine the relative effect of riveting and welding on red lead and iron oxide paint between joint surfaces, and found that the rivets, when hot, destroyed a very appreciable area of the paint around the rivet. This test will be found in the April, 1927, JOURNAL of the American Welding Society.

In view of what I have said, it is recommended that the use of paint between the joint surfaces of riveted joints be omitted whenever it is necessary to weld their edges. If this is done, not only will there be fewer leaks when the joints are tested by hydrostatic pressure, but inspectors will have a higher opinion of the soundness of welds.

There is one phase involved in the training and certification of welders which has not been considered, namely, the welders' ability to make equally sound welds in the flat, vertical and overhead positions. When, as on some classes of work, it is possible to turn the work so that all welds can be made in the flat position, it would be unnecessary for the concern to test the ability of their welders to weld in the vertical and overhead positions. However, when, as on ship work, structural work, locomotive repair work, pipe line work, etc., it is frequently impossible to turn the work, it is essential that all welders be tested in all positions. If this is not done and failure occurs, with a resulting loss of life, a moral responsibility rests on the management of the organization employing the welders. Every arc welder employed in our organization and every student arc welder on completion of his course is required to make consistently sound welds in the flat, vertical and overhead positions.

A few years ago Mr. Pack, Chief Inspector for the Interstate Commerce Commission, showed me a number of welded joints of boilers which had failed in service. One of the joints examined had a section of a sound weld adjacent to a weld which had failed. Mr. Pack, calling my attention to this condition as an illustration of the "human element in welding," pointed out that it was "possible for a welder to weld one section of the joint satisfactorily and another section unsatisfactorily." I then inquired of Mr. Pack as to whether the section of the weld which had failed was not made in the vertical position and the sound section of the weld in the flat position. This he admitted to be the case. "There is your answer," I said. "This particular welder was competent to weld in the flat position but incompetent to weld in a vertical position, the blame, therefore, in this case cannot be charged to the process or the human element involved in the process, but to the management for not determining the competency of the welder to weld in all of the positions in which he would be required to work."

Several of the papers are noteworthy in that they have been presented by manufacturers of welded products, for heretofore, it has been difficult to get manufacturers to discuss welding and welding methods as applied to their products. Because of this it has been very gratifying to me to listen to these papers and to the extensive discussion. It is hoped that from now on we will see a remarkable increase of papers from manufacturers, and if we do, it will be a decided help to the advancement of welding in industry as a whole.

Mr. Shanor: I wanted to answer Mr. Burkhart on the welding of the thick plates. The bottom of the V will be the angle until the groove is wide enough to allow a welder room to work, then the sides go up at an angle of about 10 deg. If I said parallel, I meant approximately parallel.

Chairman Lewellyn: Equal on both sides. Has that actually been tried out, Mr. Shanor, on thick material?

Mr. Shanor: Yes. Within the last three months we broke a cast steel cylinder on our hydraulic press. This cylinder is 36 in. in diam-

eter and had 9-in. walls. The crack was about 10 in. long. We welded this break in the 9-in. wall that way.

Mr. S. W. Miller: With regard to the point that has just been spoken of, Mr. Chairman and Gentlemen, it is an exceedingly old practice. I myself used it many years ago. The best theoretical shape is that of a parabola, a section of the weld being a parabola. The difficulty lies in forming this shape. With a parabolic section the amount of weld metal needed is only two-thirds that of a straight V.

I want to add my little word of emphasis to this matter of procedure. It cannot be stressed too strongly. Any defective welds that have been found are due solely to the fact that the procedure in making the weld has not been correct. In the last three or four years very great stress has been laid on the matter of procedure control. It was found that it was necessary to do in welding just what is done in any other manufacturing process, and that is to see that each step in the process is properly carried out. There is no difference in the application of procedure to welding from its application in any other process. Machine operations have to be inspected and have to be carefully designed, and the use of proper machines and apparatus and measuring tools and the other appliances that are employed in these mechanical processes have been carefully developed by years of experience and are used by the manufacturers to insure the quality of the product.

Procedure control in welding is nothing different. Proper apparatus, proper materials, proper design and proper inspection, supervision and testing are the same items in the chain that make welding a success as well as success in other more mechanical operations.

I just want to say one word. I may be pardoned for saying it, I hope. The matter of welded pressure vessels has been very close to my heart for many years, as most of you know, and it is a matter of considerable pride with me that the development of welded pressure vessels has reached the point at which it has arrived. When I first began to get interested in it, it was anathema to everybody. Nobody believed that it could be done.

I asked one inspector why he opposed welding so strongly and the answer I got was, "I don't believe in it." That was the attitude, gentlemen, not many years ago, and I think you all take pride in the work that has been done in that time and in the standing that welding of pressure vessels has at the present time.

I want to read you something that I wrote seven years ago and I may be pardoned for referring to it, because I believe that it was written at the end of a series of tests on welded pressure vessels, the results of which were the first ever published in this country.*

(Reading: "It should be noticed that during the welding of these tanks almost everything was done that should not have been. The plates were badly rolled, they were out of line and flat, and fitted up

*"Some Principles of the Construction of Unfired Pressure Vessels," published in *Mechanical Engineering* for July, 1922.

badly. The 'V's' were made with a cutting torch, and the welding was done with little regard to method and system. There was no preheating of the seams when the second side was welded, nor were the seams annealed nor the shells rerolled to bring them more nearly to a truly circular shape. Also the heads did not fit the shells, as the latter were not circular. All of these were bad practices for a vessel designed for high-pressure work.

"There were, however, four precautions taken. The plate was of low tensile strength, the wire of high tensile strength, the weld double 'V' and the welding well done. So that in spite of the bad practices the results are, in my judgment, very satisfactory, and resulted in safe pressure vessels. You may fairly ask if I would allow such bad practices in regular work, and I would reply without hesitation that I would not subscribe to any such conditions at all, because it is cheaper in a properly equipped shop to do the work right than to do it as these tanks were done. This is aside from any question of safety or of good work, which are always paramount. How many of the precautions noted above should be taken in any case, depends on the conditions under which the tanks would be used and so cannot be generally specified. But it seems clear that the proposed method of using low-tensile-strength plate, high-strength welding wire, both of proper quality, with such other precautions as may be needed, will result in uniformly safe work."

Those vessels were designed for 360 lb. working pressure. They were half-inch in thickness and 24 in. in diameter, and were tested to as high as 2400 lb., with no failures except pinholes or small cracks. None of the seams ruptured.

Chairman Llewellyn: There is something in Mr. Miller's remarks that reminds one of the saying that when a man starts a new idea he is called a crank; when people begin to find there is some merit in it he is called an enthusiast; when everybody embraces it he is called a hero.

It is a little after 5 o'clock and I wonder if Mr. Moss or Mr. Candy would like to make any general reply to the discussion that has occurred.

Mr. Candy: I would like to ask Mr. Loos in his experience with structural work what his practice is where he has members that have been cut with a gas torch relative to removing the scale and tear drops that may form on the far side of the work before any welding is done.

Chairman: Do you refer to what I might call big scale or fine scale?

Mr. Loos: I believe it is the practice in that case to chip off the burned edges. There is very little of that done at the present time. The welding is largely carried on along rolled and sheared edges.

Chairman Llewellyn: I think that is a very good point. There has been some confusion due to the use of the word "scale" to cover two quite distinct things. Will you care to speak on that point, Mr. Moss? I am talking about scale formed by flame cutting.

Mr. Moss: Mr. Chairman and Gentlemen: On that point, as long as Mr. Miller is here, I would rather refer that to him.

Mr. S. W. Miller: Melted steel has a strong solvent power for iron oxide. In the cold it has practically no solvent power. Therefore, any means that can be taken to keep the scale of whatever kind out of the weld is going to result in a higher strength and greater ductility.

When a non-metallic material like iron oxide is in a piece of metal, regardless of whether it is in a weld or in the base metal, as it has no strength, and as it usually lies in the form of round globules in a weld, its strength at the edges of that globule is very much less. I might put it a little better in another way: The stress at the edge of a hole in a plate is three times the average stress across the plate and is independent of the size of the hole.

It has been amply proved that the existence of any considerable amount of non-metallic impurities in steel decreases its strength, though it is, of course, impossible to make any steel entirely free from them, and the better commercial grades of steel are as clean as can be expected. It is very interesting to take a piece of steel or a piece of a weld that is badly made, shot full of particles of iron oxide or similar oxide, polish and etch it, and bend it under the microscope. The first evidence of any distortion or of failure of that piece is at these particles of oxide, and in some cases the rupture occurs through a number of them before any evidence of strain inside the grains is shown.

I think it can be stated in general that the first evidence of distortion in any piece of metal is at some visible defect. The next probably will be at grain boundary defects, which even at the highest power are not visible.

Therefore, I would say that if you want the best quality welds, remove all the scale from the surfaces on which the weld is to rest. Also take precaution against the sparks from the welding material flying on to the surface of the V that has not yet been welded. In some cases that can be done by laying a piece of square steel ahead of the point where the welding is being done and moving it along as the welding proceeds. Such spattering of the metal in the welding rod may be overcome quite well by using the better types of rods. In some cases it makes no difference whether you do have a defective weld of that character. If the weld is entirely in shear, it isn't so important. If it is in tension, it is. In compression, it is hardly vital. But when you want high quality welds, keep away from any form of oxide, either that found on the surface as it comes from the mill commonly called mill scale, or that formed by the cutting torch during the process of fabricating.

Mr. Moss: Mr. Chairman, I am very glad to have the opportunity of making a few remarks. In behalf of the Committee on Standards for the Qualification of Construction Welders, I wish to express its appreciation for the splendid support which the gentlemen, scheduled

on the program, have given to the subject of this meeting, and also that given by the various members participating in the discussions. It is, indeed, regrettable that the Committee was unable to furnish all of the speakers with a copy of its paper before this meeting, but this was impossible. On the other hand, the proceedings of this meeting have brought out a number of splendid points which have not been influenced in any way by anything the Committee has expressed and I think that we have all benefited more so on that account. I know that the Committee has. It is hoped that the discussions which the Committee has enjoyed today will not terminate with this meeting, but that you will give the subject of Standardization your further consideration and will communicate your opinions and suggestions to the Committee. We have a big problem before us and we want to work it out complete for the various branches of construction welding to be undertaken and practical in all respects, and the Committee will appreciate your cooperation and will give careful consideration to any suggestions submitted to it.

FRIDAY MORNING SESSION

April 27, 1928

Discussion paper on "Welding the Ford Car" by Mr. M. L. Eckman.

Chairman P. W. Swain, McGraw-Hill Publishing Co.: We wanted to have at one session a paper of a general interest to a good many people and we especially desired a paper on the welding of the new Ford car. We were finally able to obtain just what we wanted. I have looked over the paper of Mr. Eckman, who is Welding Supervisor of the Ford Company. As far as I can see, almost everything in the car is welded except the tires and the windshield. That is a matter Mr. Ford will have to look into.

It is highly significant that Mr. Ford, whose work has had such very great influence on industry in this country and particularly on the automobile industry, seems to be fully sold on welding and is using welding in so many ways.

I shall now turn the floor over to Mr. Eckman, Welding Supervisor of the Ford Motor Car Company, who has some very interesting things to tell us. *Mr. Eckman presents paper.**

Well, I am sure I didn't exaggerate when I said that was going to be a good paper. By this time we should, perhaps, be immune to shock when following Mr. Ford's activities, but just about the time we have got accustomed to his latest advances he comes along with something new that gives us a bigger shock than ever. Mr. Ford's accomplishments are the working out of a very open mind. He has gone as far in welding, I am sure, as any welding engineer would have suggested. There is about a half hour left for discussion and we shall be glad to have your comments on the paper.

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*Paper published in the May, 1928, issue, JOURNAL of the A. W. S.

Mr. Herman N. Lemp, Ingersoll-Rand Co.: I think the paper presented by Mr. Eckman this morning is a wonderful piece of work all through. It shows an achievement in practical welding I will not say "not dreamed of by engineers," but certainly realized much faster than was hoped. I have noted that Mr. Eckman all through has strictly adhered to the technical term of "resistance welding" and yet a few times he has remarked upon an arc in connection with the explanation of resistance welding. To be technically accurate, it is usually conceded that it takes about 15 volts in order to properly create a metallic arc. The transformers which are used in this welding process, which is termed "resistance welding," usually go as high as five or six volts, seldom except in special applications to 10 volts. What Mr. Eckman probably means is that an imperfect contact with a large volume of current passing through that imperfect contact causes the sparks which would be a truer explanation than to say an arc.

I am a great admirer of Henry Ford. He is a wonderful man. He has done what many people tried to do but did not succeed in doing. I have the honor of personal acquaintance with him and yield nobody my admiration for him, but if Mr. Eckman will permit me to say, there is a saying in the Bible—"And the bread that you cast upon the waters returns," but sometimes it is somebody's else bread.

In all this talk I think we should not forget the originator of this process. I mean Prof. Elihu Thomson. He is the one who conceived what you now term "resistance welding." He had the dream all worked out. He coined the words "electric welding." If you will read the original literature on electric welding you will find that the great stress he laid upon the development of his process was that he was going to create a new process of working. He furnished the trade a new tool by means of which manufacturing processes can be speeded up, and, as Mr. Eckman stated, with correct alignment, well-produced welds can be made automatically.

Prof. Elihu Thomson is considered one of the illustrious scientists whom America has produced. There is nothing I can say here that will add to his reputation, but I believe in justice to him the originality of the process should be jealously guarded, even if the later development of the art has taken it partially out of his and given to the willing hands of young, energetic men to further work it out.

Practically everything which has been shown here today has been anticipated by Professor Thomson. The only later brother of the original conception was that variation known as spot welding. The courts declared it was really part of the original process, but it was not used in the early part of the development of the art. It only came toward the end of what you may call the life of the fundamental patents.

Mr. Eckman has made a very interesting statement regarding removing burrs from pipe. The blowing out of the burr from the inside is a new one on me.

I would like to ask Mr. Eckman what are the kilowatts per metal section used nowadays for this flash method of resistance welding?

One of the difficulties in introducing the process was the apparent enormous amount of energy required even for a short period.

When in the beginning customers were told that about 40 to 80 kw. were required for commercial sections up to 8 sq. in., people were aghast. They said, "Nobody but millionaires can afford such a process." As a matter of fact, in spite of all these handicaps it did prove successful. Welders were built from 1 kw. up to 640 kw. I will close my remarks by saying I am very much pleased to see that the foresight of Mr. Ford has vindicated the foresight of Prof. Elihu Thomson.

COMMUNICATED BY MR. LEMP AFTER DISCUSSION

The above remarks were prompted by the closing statement in Mr. Eckman's paper in which he probably unintentionally conveyed the impression to the audience that the resistance welding as practised in the Ford works was an entirely new process in lieu of an adaptation of the original Thomson Process, with some of the apparatus designed and originally built by the company bearing the inventor's name. For the benefit of the younger welding engineers an accurate adhesion to historical fact when presented on the floor of a technical society should be paramount. Mr. Eckman himself admitted "It was before his time." My remarks were intended in the kindliest spirit and in a just appreciation of the practical application of electric welding on a vast scale in the new "Ford automobile."

Chairman Swain: Perhaps Mr. Eckman would care to very quickly answer just one or two points Mr. Lemp brought out and then we will go ahead with the next discussion.

Mr. M. L. Eckman, Ford Motor Company: I am not a scientist at all, but I will tell you this: From personal observation we have rigged up an affair and got close to these welds and taken motion pictures of these welds. As near as we can tell from observation, there is an arc drawn there. Whether it is the partial contact gasifying the metal and then the current traveling on this gaseous metal back and forth I cannot say, but you can see it flashing back and forth like that. You can see what's happening there. I am not here to argue the scientific side at all, but I do know it has all the appearance externally and in every way of an arc. I think that will answer the question. Mr. Ford is a man who is not much given to going by what some scientist tells him. He believes what he sees, and he trains the workmen under him the same way. We are told to go out and find things out, get facts, never mind theory, etc.

Now about Professor Thomson. Far be it from me to detract from that gentleman. He was a pioneer in his field and should be so honored by all thinking men. The only reason I didn't bring him in this morning is he was born considerably before my time and all I know about him is what I have read. We should give him all the credit in the world. As you know Marconi originated the wireless, but Dr. De Forest improved it with the radio tube and we give both a lot of credit. Professor Thomson and Mr. Ford are comparable to them.

Now about the kilowatts, I think there is a little mistake about this. It is true that we have an immense plant and many millions involved, but in making a 1-in. weld we only take about six-tenths of a kilowatt-hour. That is the basis of figuring. We go much under that in many cases.

We came to the City of New York and in a very few hours we had sufficient current from your local power company to run welders. We went to Chicago and did the same thing. In Detroit there are many jobs using 220 volts right off the ordinary line. Possibly they do need considerable power, but the general trend of electrical conditions all around the country is for more power. So I think it is right in line with that development.

Mr. Lemp: You are using lots of power and you have the power behind you which other men didn't have at the time.

Mr. J. C. Wright, Director, Federal Board for Vocational Education: Major Eckman has raised one issue in which I am vitally interested, and it has to do with the question of training. He stated that during the 16th or 17th Century a number of iron welds had been made by the old hand process, into which the workman had injected his pride and individuality. We are today facing a problem in vocational education which we do not know how to solve, and I think the problem is even more pronounced in industry. I refer to the loss of "job pride" which causes the workman to lose pride in workmanship and to be satisfied with turning out a product that does not represent his best efforts. As industry has created more automatic machinery, and as industrial organizations have become more specialized through breaking up the old skilled occupations, it appears that "job pride" has been proportionably lessened.

Under modern working conditions, where the worker makes only one part of the completed product, or what is still worse, where he does not even turn out a finished part, but performs only one or more operations in the construction of a single part, the workman cannot view the finished product, be it automobile or a pair of shoes, and say: "That is the result of my skill and of my technical ability." His efforts have been merged, along with those of other workmen, into the completed article, and for this reason he loses the sense of "job pride," and it is only natural that the quality of his work should suffer in proportion.

There are approximately 1,000,000 boys and girls, men and women, in vocational schools throughout the country. Many of these are evening classes and part-time schools into which those who are at work come for the purpose of getting additional instruction and training which will enable them to get a better job. I know of no teaching device by which these men and women, boys and girls, may be taught "job pride," at least where the efforts may be carried on in other than through indirect procedures. It is my opinion that even though the school was able to turn out a satisfactory worker in this respect, that the individual would soon begin to deteriorate under modern working

conditions. It seems to me that in some other manner industry itself must organize its operating personnel so as to keep this very desirable quality at its maximum.

Where foremen have been brought together in conference under the leadership of a trained conference leader, their attitudes toward the workman have been materially improved, and perhaps this is the answer to the question.

Chairman Swain: That discussion reminds me that somebody yesterday, in discussing Mr. Moss' paper, suggested that on the fabricating work it might be worth while in some cases to have the individual workman on any weld put his own little hallmark on that. There may possibly be something in that. Has any one any suggestion they would like to make along that line?

Mr. Eckman: Could I ask this gentleman what his business is?

Mr. Wright: I am the Director for the Federal Board for Vocational Education in Washington.

Mr. Eckman: He brought the thing home to us much better than I could do it. Just what he said is true. We are trying to pick out men of the right character, men of integrity. A man came to me the day before I came to New York and said, "I made an airplane part and I am ashamed of it." I would give that man a raise. That is the way I felt about it. He had the right idea. I want that to go around through our welding organization. We want the rest of the fellows to know that, not that I am encouraging them in making mistakes, but the honesty of purpose, that is what I wanted to emphasize. That is one of the things we are trying to do—trying to get the right sort of fellows, fellows that have integrity and who will stick to a job and have a vital interest in it themselves, fellows that are proud of their work. I have often thought if I didn't have right now the most interesting job in the United States I would like to have a job studying men and trying to place men. I don't know how to do it always and I have talked to many men along that line and can't find out a great deal, but some day we will have learned how to do this.

Chairman Swain: The point was raised here about training executives and designers, it being easier to get a man whom you can train to do a piece of work than to get an executive who knows what the work is about. That is quite a problem in industry. Men get into executive positions without having come up through the ranks and they sometimes think it necessary to pretend that they understand certain processes when, in reality, they do not. Such bluffing is often disastrous.

Do you think, Mr. Eckman, that it would be a good thing if executives who head plants or departments where a great deal of welding work is done should be required to take a course with a torch or arc?

Mr. F. E. Rogers, Air Reduction Sales Co.: What Mr. Eckman said about the need of training the executives, of course, is an old story in the welding industry. Welding, we often say, has come into the plant

through the back door. Or, in other words, it has filtered from the lower strata up. The executives are just learning today—many of them—that there is such a thing as welding, and I believe that Mr. Ford's example in welding the Ford car is going to do a great deal to advertise and promote more welding of all kinds.

I would like to have had Mr. Eckman bring out one thing which, perhaps, was quite obvious to him but which he did not emphasize quite as strongly as I would have liked. The American Welding Society and other organizations and individuals have spent much time, it seems to me, in discussing the integrity of welders and sound welds; how to make sound welds and how to know when they are sound. It is quite clear that in the work Mr. Eckman is directing they have proved certain fundamental points. They know, if they have certain voltages and amperages for a cross section of metal and have worked out the welding procedure, that one weld made today would be equally good as a weld made in the same way tomorrow. I would like to hear Mr. Eckman develop that a little more if he will—the integrity of the welds; why they believe and know that one weld made today is as good as one made tomorrow, and so on.

Mr. Eckman: This gentleman wanted to know how we knew that we made a good weld today and knew that the same thing could be duplicated tomorrow.

Mr. Rogers: Perhaps that was rather a crude way of putting it. What I am getting at is the selling of the idea of welding and believing in it. We who are familiar with welding know that a weld made under certian conditions is dependable. The difficulty we find is proving to the inexperienced man that that is so. What I hoped was that Mr. Eckman would say something in his own language that would emphasize the dependability of welding more specifically when the necessary factors and procedure were known and practised.

Mr. Eckman: Well, in our factory, we have done some welding jobs so long that everybody, even the various boys around there, knows that welding is good. For instance, on the old Model T, what we call the clutch shaft was a welded job. Every time you push down on the clutch pedal on every Ford of the Model T that is driven around the country you put your confidence in a weld. How many can recall where a clutch-pedal shaft gave way? That is one thing I have used in our plant among our own executives when the dependability of a weld is questioned.

Another thing: All our chains around the shop are flash welded. All our hooks and king rings for lifting material (that is heavy loads), are welded jobs and they have been in use for years. They are periodically annealed to keep away from crystallization, but we don't have any trouble along that line. There are other things that are welded from one end of the shop to the other. You can stand in any corner of the shop and see things that are welded in use every day, and whenever something comes up like that and they want to know why we think this is going to be good and why we know this weld is going to stand up, the answer is before them. We try always to select

the best method of doing the job and then we test it to our own satisfaction and it is sent to the laboratory and it is tested to their satisfaction. We have our own results and the laboratory results. All over the shop we have tested different things under different conditions and proved what is good and what is bad. We have volumes of data of all kinds, and data do not mean very much any more.

Usually we go out and pick out a job and say, "What is the matter with that job? That job has been welded and has stood up for a long time." They can't find anything the matter with it! Well, we can make this other part just as good and can show them by practical results and usually if it looks good, it is OK'd and goes through. We have a great many hands to go through. Mr. Ford has many watchdogs on different articles. It isn't only a case of our saying a job is good. It has to pass several critical men and they are hard-headed and have to be shown and that keeps us from going too far sometimes. I believe this answers that question.

Mr. Lemp: Has it not been your experience, Mr. Eckman, that the reason why you chose the resistance process was because it yields itself better than any other to semi or absolutely automatic machinery in which the personal element is taken out?

Mr. Eckman: It is the best method known for repetitive processes where you have the same thing over and over again. We don't know any method of manufacture or assembly that comes anywhere near it. That is the reason we are using it.

We have no prejudice in welding. We use all kinds and each type of welding has its particular and peculiar field and that will always be so. Resistance welding of the type that we have, though, lends itself to rapid production and strength better than anything we know of.

Mr. J. C. Reed, Bethlehem Steel Co.: I would like to ask Mr. Eckman in regard to his arc welding of the tube in which you stated that you got a speed of about 37 seconds for a distance of about 2 feet. How many heads do you use to obtain such a speed?

Mr. Eckman: One head.

Mr. Reed: You are laying a bead along there at the rate of 24 inches in 37 seconds.

Mr. Eckman: To be correct it is 20⅝ inches in 37 seconds. It is 5/32 inches wire and ⅛ stock. I would like to hear from some of the rest of you gentlemen about that speed. We think it is pretty good.

Mr. Reed: I'll say it is.

Question: What is your amperage?

Mr. Eckman: It runs 290 amperes, about 30 to 35 volts.

Question: Can you get a continuous perfect weld?

Mr. Eckman: Yes. We do have some of what you call recoopering. That will happen. Probably you fellows who are handling arc welding

know that as well as I do, especially automatic. Your arc snuffs out occasionally and you get a little dirt on your job. Possibly a crane down here starts to pick up a big load about the time the automatic is feeding. That may affect you a little bit. There is a little recoopering done but it is getting less and less every day. For instance, we are making pretty close to 6000 of those tubes in 24 hours and there are about four men recoopering by hand. Most of that is on the end, by the way. There is a little crater left where you start and also where you stop. In between it is pretty good. Maybe one in fifty tubes might have a little spot on it. I can show you hundreds of them that are perfect.

Question: What sort of a cleaning operation do you have on that?

Mr. Eckman: We wash it. The steel itself is pickled and then it is washed, but occasionally there is a little lapse occurring. You don't pickle it correctly or don't wash it right and we get a little dirt on it. If you put a little dirt on it, you can see your arc hit that little piece of dirt.

Chairman Swain: I want to extend the thanks of the Society to Mr. Eckman for the very valuable paper. There was a lot of real information in it.

...The session adjourned at 12:00 o'clock...

*Control for Welding

By H. L. WHITTEMORE†

CONCRETE construction and welding have a good deal in common. In both processes material in a plastic condition is given the desired shape and later is expected to carry the stresses which occur in the loaded structure.

For success in either process it is necessary to carefully follow a procedure control which research has shown to be necessary. Of course, at first it was confidently expected by enthusiasts that anyone who could produce reasonably good looking work would obtain satisfactory results. Failures proved that skill and experience were more necessary in these new processes than in those which they replaced—just another illustration of the theory that life is becoming more complicated every day.

Concrete construction is, let us say, twenty-five years older than welding. Anyone who thinks that the procedure controls which are being prepared for welding are too elaborate should study the literature on concrete procedure. Apparently the cement industry thrives on the fact that its material must be used "just so" if the results are to satisfy the purchaser.

The welding industry can with profit consider what procedure control has accomplished for concrete and apply the lessons to welding procedure. The *Engineering News-Record* for April 26, 1928, Vol. 100, No. 17, p. 660, gives the experience of Mr. E. A. Kemmler in making compressive tests of cores taken from concrete roads to control the quality. He gives the graph reproduced here which is self-explanatory.

Note the increase in strength (quality) with the increase in control and the rather startling fact that the difference in quality between "Fair Control" and "Good Control" is negligable. The latter also gives a quality which is 41.2 per cent above the specification minimum. The cost data given in this article show a gradual decrease from year to year, which is proof that the contractor, at least, does not find that procedure control a burden.

There is one important question which should not be overlooked: Was the quality obtained during the last two years the result of knowledge on the part of the contractor that his work would be tested and poor work almost certainly detected? This seems unlikely because this influence must have been felt in 1924 and the improvement in quality that year was slight.

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*Publication Approved by the Director of the Bureau of Standards of the U. S. Department of Commerce.

†Chief Engineering, Mechanics Section, Bureau of Standards.

The quality of the concrete seems to have depended almost entirely upon the "Control" worked out and enforced by the city officials at the time the pavement was laid. The core tests were simply the yardstick by which the quality was measured. If this view is correct, the quality of the pavement would have been the same if the cores had not been taken.

If further experience with welds confirms this viewpoint we may expect that the quality of welds in the future will depend upon the procedure

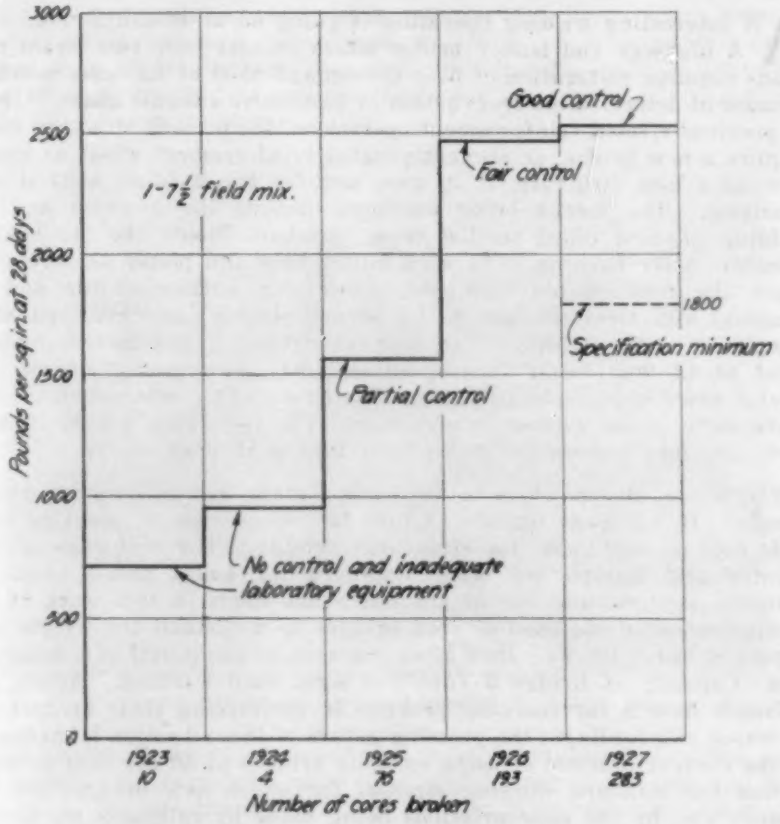

FIG. 1. INCREASE IN STRENGTH OF CONCRETE BASE IN FIVE YEARS

control and the care with which it is followed. Tests of welds taken from the completed structure, always an expensive undertaking, will then give an indisputable measure to the quality if it is needed as in a lawsuit.

We have reason to expect, then, that the quality of commercial welds will increase as we learn more about how welds should be made and as the men interested in welding work, either as producers or consumers, become more familiar with this remarkable method for fabricating structures.

Arc Welded Buildings and Bridges*

GILBERT D. FISH†

AN interesting welding operation is going on at Bound Brook, N. J. A highway and trolley bridge which crosses over two steam railroads requires restoration of floor system and most of its truss members because of deterioration from action of locomotive exhaust gases. Owing to previous riveted reinforcement operations, the present situation would require a new bridge, or else complicated reinforcement about as expensive as a new structure, if it were not for the welding method now available. The means being employed include the erection and arc welding of new rolled section truss members inside the old latticed members after burning away such lattice bars and plates as are in the way; the replaced old members, comprising bottom chords and all diagonal web members, are to be burned through and removed after completion of the welding. The floor reconstruction will include replacement of all floor beam flanges, all stringers, cantilever footwalk and lateral brace rods, welding to be used throughout. Interurban electric traffic is to go on without interruption. The two spans are 85 ft. long each; the four trusses are of the pony type, 9 ft. deep overall.

The Bound Brook job is in too early a stage for construction photographs. It has been introduced into this discussion as pointing to a wide field of usefulness for structural welding. The highways of this country and Europe are being improved for heavy motor traffic at immense expense, and one of the important items in this work is the reinforcement of old steel or iron bridges to withstand the weight and impact of heavy trucks. How often one sees, at the portal of a bridge, a sign "Capacity of Bridge 5 Tons", or some such warning. Again, the railroads have a far reaching problem in reinforcing their bridges for increased axle loadings; the pressing nature of this situation is evidenced by the current practice of using existing bridges at 50 per cent or more beyond the standard working stresses for which new bridges are designed; also by the appropriations being made by railroads for bridge reinforcement. The considerable use which has already been made of arc welding for reinforcing bridges both on railways and on highways, and the recent completion of two new all-welded railroad spans, are now causing engineers and bridge building contractors to study this modern structural method in connection with plans for bringing old bridges up to date.

Building construction and alterations and additions to existing buildings form a wider field for structural welding than is offered by bridges. The economies of welding as compared with riveting are based on the

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†Consulting engr., Westinghouse Elec. & Mfg. Co.

same reasons in building operations as in bridge work, but appear to be less striking in buildings because there is a smaller percentage of connection material to be saved.

Alterations bring out cost saving advantages of welding more conspicuously than do new structures, because of the facility with which new steel is connected to old without drilling holes. In new construction, the economies made possible by welding consist generally of reducing the quantity of steel required and in simplifying fabrication.

I will review briefly several completed structures with which I have been connected, pointing out in each case the high lights which seem to me to contain the most useful lessons. None of these operations is offered as a model, because it is evident that each could be improved materially in the light of experience already gained and of suggestions made by visiting engineers.

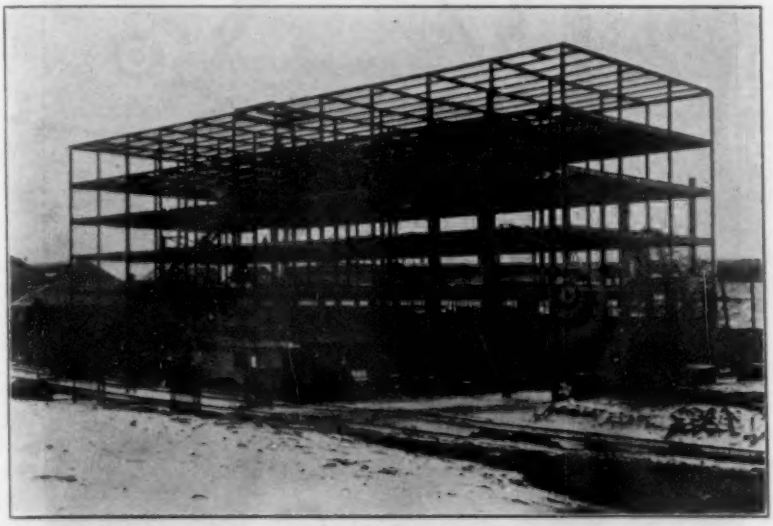

FIG. 1. WESTINGHOUSE ARC WELDED BUILDING, SHARON, PA.

The Sharon Building, pioneer heavy building construction by the welding method, was completed as to steel slightly over a year ago and is in use as a manufacturing building by the Westinghouse Electric & Manufacturing Company, owners of the plant and sponsors of the method. The principle of beam and girder continuity was used throughout, tests of full-sized cantilever joints having demonstrated that the full bending strength of members could be developed by arc welded connections designed for the purpose. Continuity reduced the required size of beams and saved about 10 per cent of the total steel in the structure. The joint details used for effecting continuity were not economical; but instead of deciding that continuity is not worth while, we have since devised different connections by which continuity has been effected with resulting net saving. Reduced deflection and vibration is an advantage in some cases, apart from cost consideration.

The plate girders in the Sharon Building were probably the first practical example of the assembly of heavy beam sections from plate material only. There is a considerable saving in weight of steel due to increased effective depth, absence of rivet holes, and use of plates instead of angles and fillers for stiffeners. The stiffeners are made more effective than in riveted construction by welding them to the flanges. The flanges of these girders, including covers, are about 4 in. thick;

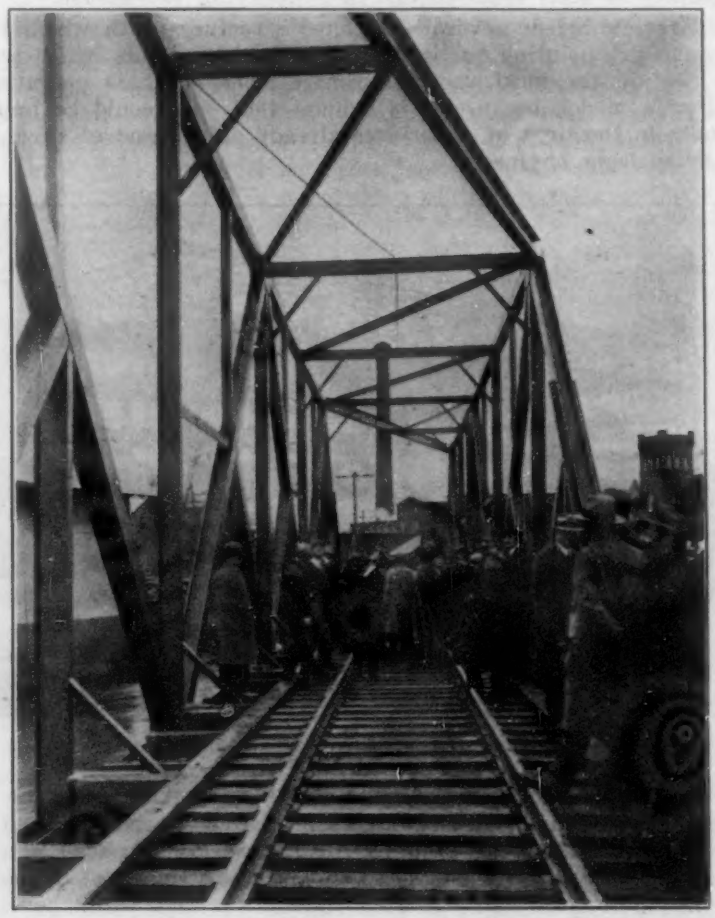

FIG. 2. INSPECTING PARTY, CHICOPEE FALLS BRIDGE

one pair of girders weighs 18 tons and carries a column load in excess of 160 tons at the middle of the 45-ft. span.

The one story kiln tunnel building of the Westinghouse Co. at Derry, Pa., was interesting for its bare simplicity of detail, for its use of 60 per cent plain material shipped from rolling mill to site, and for the fact that all welding was done in the field. Due partly to saving in material and partly to simplification of processes, a cost saving was

effected as compared with riveted construction, this saving amounting to 13 per cent according to estimates by Jones & Laughlin Steel Corp., the contractors.

The Derry Building columns were milled and punched, but rafters and purling were shipped as plain material with common mill tolerances in length. Single side connection angles, punched in one leg to match holes in the columns, were welded to the 18-in. and 24-in. I-beam rafters on the ground before erection. Small pieces of 5-in. channel were welded to top flanges of rafters before erection, to serve as receptacles for the 7-in. I-beam purling. The holes in rafter connections and columns were for erection bolts only, two at each end of each rafter.

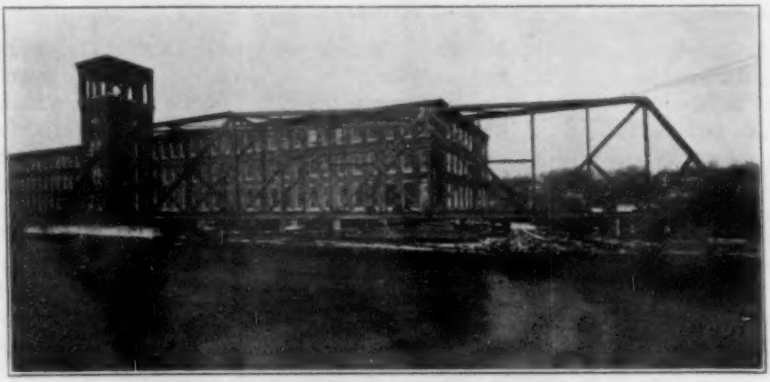

FIG. 3. ARC WELDED RAILROAD BRIDGE, CHICOPEE FALLS, MASS.

Bolts were not needed for the purling, but were used for spandrel members. The rafters were not welded directly to the columns but were welded to the side angles and the angles in turn to the columns, it being considered dangerous to make a direct beam to column weld unless the connection is designed with enough bending strength to hold the beam horizontal at the end under maximum loading. The purlings were made continuous, thus permitting use of 7-in. instead of 8-in. beams.

The 55-ft. span plate girder bridge at Turtle Creek, Pa., which has been several months in service on the line of the Westinghouse Interworks Railway, was probably the first welded railroad span to be completed. It uses plate girders made from plate material only, and floor system composed of rolled beams. The stringers were made continuous through supports, not merely because of the greater carrying capacity of beams of a given section when made continuous, but because of the superior fatigue resistance of joints which hold the beams horizontal and motionless at the supports. At these joints, tension bars were passed through slots in the floor beam webs and welded to top flanges of stringers, the bottom flange thrust was accounted for by fillet and butt welding, and vertical reaction was provided by vertical fillet welds at stringer webs.

The Chicopee Falls Bridge, first welded truss bridge, carries a spur

track from a plant of the Westinghouse Co. across a canal to connect with the Boston & Maine Railroad. It is a single track through truss skew span, designed for Cooper's E-50 Specification loading, with impact allowances based on low speed service. The truss span is 134 ft. 8 in., but on account of 72 deg. skew the tip-to-tip length is 175 ft.

The most striking feature of this structure is the saving of one-third of the 120 tons of steel required for a riveted bridge of the same dimensions. This comparison is based on an actual design, the only interference with a true comparison being that the riveted design employed latticed members for the trusses, whereas the welded design used rolled shapes of the Carnegie wide-flange sections. The savings resulted from elimination of the bulk of connection material, absence of holes in tension members, and continuity of stringers.

A variety of weld types appear in this bridge, including slot welds in longitudinal shear, fillet welds in longitudinal and transverse shear, and butt welds in shear, tension and compression. The slot welds, which are ½ in. square in section, are an innovation and have proved satisfactory in execution and in laboratory tests; their test values for ultimate strength are about 25,000 lb. per linear inch, as against a working stress of 5,000 lb. in this job. Fillet welds, ⅜ in. size, have been extensively used on so many structural jobs that no special comment will be made except to state that 2,500 lb. per linear inch is the design stress for shear in any direction, a very conservative figure. In butt welds, mean shearing intensity has been limited to 9,000 lb. per square inch, maximum tension 13,000 lb. per square inch, and maximum compression 16,000.

From the standpoint of economy, some features of the Chicopee Bridge seem to be definitely worth repeating in future bridges of this sort; others could apparently be redesigned with marked improvement. The dimensions, paneling and arrangement were copied from the riveted design for the sake of direct comparisons and to avoid delay. There would probably have been some saving in substituting two lines of stringers for four, a change made possible by the effect of continuity in reducing required depth of stringers. The H-shaped truss members might well have been placed with webs instead of flanges vertical (as in the new Bound Brook job), thus reducing upkeep expense involved in cleaning out the horizontal members and in more frequent repainting. Some at least of the butt welded joints would have been more economical if gusseted, because the beveling of flanges in preparation for butt welding was an appreciable item.

Regardless of certain economic shortcomings in design and details, the Chicopee Bridge cost much less than a riveted equivalent. Periodic inspections are to be made for information as to serviceability.

Machine Cutting in Railroad Shops*

By WESLEY WIGGIN

FEW people realize to what extent machine cutting has developed during the last few years, and still fewer people realize to what extent manufacturing costs have been reduced, speed of production increased, and floor space saved.

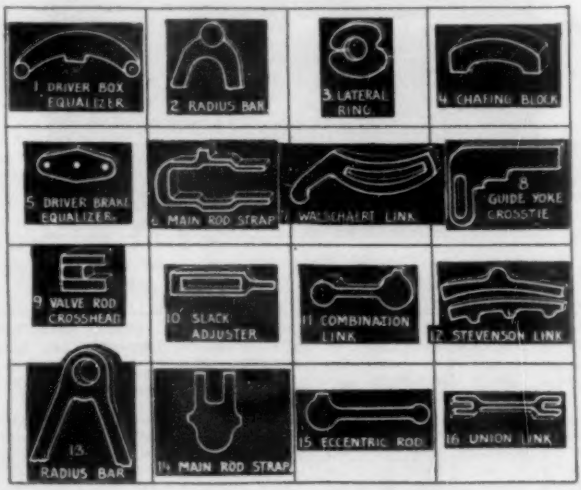

FIG. 1

NAME OF PIECE.	LENGTH OF CUT LINEAR INCHES	THICKNESS OF STOCK INCHES	CUTTING TIME MINUTES	GAS CONSUMPTION OXY-GEN CU.FT.	GAS CONSUMPTION ACETYLENE CU.FT.	TOTAL GAS COST $	TOTAL LABOR COST $	TOTAL GAS+LABOR COST $	NO. OF PIECES CUT IN 1926	COST OF MANUFACTURE OF THESE PIECES. BY CUTTING $	COST OF MANUFACTURE OF THESE PIECES. BY FORMER METHODS $	CUTTING HAS SAVED $
1. DRIVER BOX EQUALIZER.	89"	1⅞"	6.3	14.6	1.5	.25	.12	.37	889	328.93	2089.15	1760.22
2. RADIUS BAR.	198"	2"	14.5	42.	2.9	.69	.84	1.53	28	42.84	233.80	191.00
3. LATERAL RING.	94"	½"	5.2	9.1	1.	.16	.12	.28	375	105.00	285.00	180.00
4. CHAFING BLOCK.	64"	10⅞"	16.	182.4	3.2	2.80	1.01	3.81	78	297.18	465.66	168.48
5. DRIVER BRAKE EQUALIZER.	41"	1⅜"	2.9	6.9	.6	.11	.07	.18	643	115.74	231.48	116.00
6. MAIN ROD STRAP.	162"	6"	27.	200.	2.7	3.05	.85	3.90	57	222.30	313.50	91.20
7. WALSCHAERT LINK.	146"	3"	16.2	56.7	3.2	.91	.75	1.66	44	73.04	165.00	91.96
8. GUIDE YOKE CROSSTIE.	168"	2"	16.8	48.7	3.4	.80	.93	1.73	8	13.84	76.00	62.16
9. VALVE ROD CROSSHEAD.	58"	3"	6.4	22.5	1.3	.37	.36	.73	51	37.23	109.65	72.42
10. SLACK ADJUSTER.	84"	4"	10.5	45.1	2.1	.77	.75	1.52	84	127.68	184.80	57.12
11. COMBINATION LINK.	42"	2"	4.2	12.1	.8	.20	.62	.82	11	9.02	34.87	25.85
12. STEVENSON LINK.	122"	3½"	15.3	66.2	3.1	.98	.72	1.70				
13. RADIUS BAR.	143"	2"	14.3	41.4	2.9	.68	.84	1.52				
14. MAIN ROD STRAP.	90"	4⅜"	12.9	78.9	2.6	1.11	.82	1.93				
15. ECCENTRIC ROD.	74"	4½"	10.6	38.3	2.1	.91	.75	1.66				
16. UNION LINK.	160"	3½"	20.	80.	4.	1.28	1.09	2.37				

FIG. 2

*Abstract report presented at Boston Meeting, A. W. S., April 17, 1928.

Fig. 5 shows just one example how an intelligent man can redesign tools and save not only several thousand dollars in the course of years, but also simplify tools and handling.

Formerly forging tongs were made out of one piece, and there were a great variety of tongs, each one with different jaws to fit the different

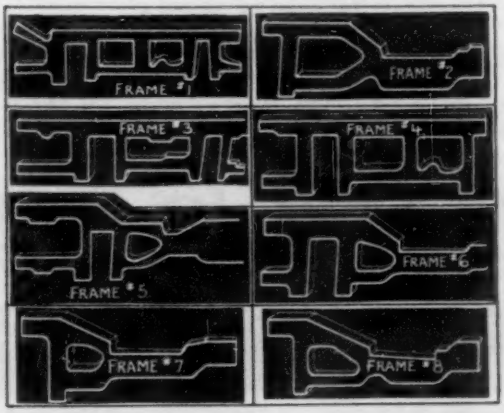

Fig. 3

LOCOMOTIVE FRAME SECTIONS.	DIMENSIONS OF BILLET	WEIGHT OF BILLET LBS.	THICKNESS OF STOCK INCHES	LENGTH OF CUT. LINEAR INCHES.	CUTTING TIME MINUTES	HANDLING TIME MINUTES	TOTAL LABOR COST $	GAS CONSUMPTION O- OXYGEN CU. FT.	GAS CONSUMPTION A- ACET. CU. FT.	TOTAL GAS COST. $	TOTAL GAS & LABOR COST. $
FRAME # 1	5"×3½"×16 m	9248.	5"	780.	130	132.	5.76	860.	26.	13.42	19.18
FRAME # 2	5"×3½"×16 m	9248.	5"	590.	95	114.	4.57	628.	19.	9.80	14.37
FRAME # 3	5"×3½"×16 m	9248.	5"	466.	66.	84	3.29	419.	13.3	6.36	9.85
FRAME # 4	5"×3½"×14 m	7092.	5"	380.	53.	72.	2.73	291.	11.	4.63	7.36
FRAME # 5	5"×3½"×16 m	9248.	5"	577.	95.	114	4.58	636.	19.	9.92	14.50
FRAME # 6	5"×3½"×16 m	9248.	5"	574.	95.	114.	4.58	632.	19.	9.87	14.45
FRAME # 7	5"×3½"×12 m	6939	5"	301.	43.	66.	2.35	271.	9.	4.25	6.60
FRAME # 8	5"×3½"×16 m	9248.	5"	400.	57	78.	2.51	360	11.	5.67	8.18
FRAME # 9			5"	1085	156.	150	6.68	976.	31	15.26	21.94

Fig. 4

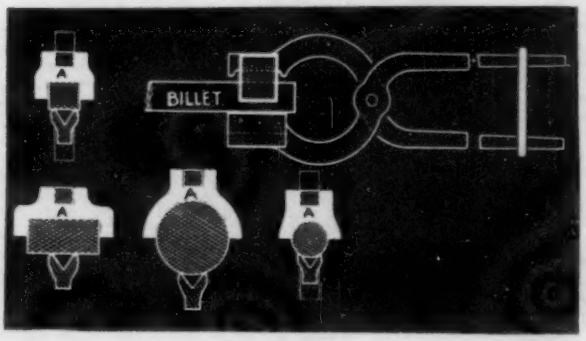

Fig. 5

bars or billets. These tongs were pretty expensive and oftentimes one had to hunt all over the shop to find the right tongs. Actually only one standard type of tongs is used to fit any shape of individual jaws. By carrying a variety of jaws cut out with the cutting machine in short order, the former stock of 20 to 30 expensive tongs has been reduced to 5 or 6 of simple standard construction and only a variety of inexpensive jaws are carried.

The man who is looking for more intimate understanding will notice that the cost of cutting is low and the speed of cutting high. This is a result of the fact that nearly all responsible pieces are preheated before being cut. This preheating before cutting and annealing after the cut is finished is the modern way of cutting responsible pieces which has eliminated all former objections against machine cutting. The heat treatment not only insures excellent quality but also reduces the cost of cutting and increases the speed of manufacture.

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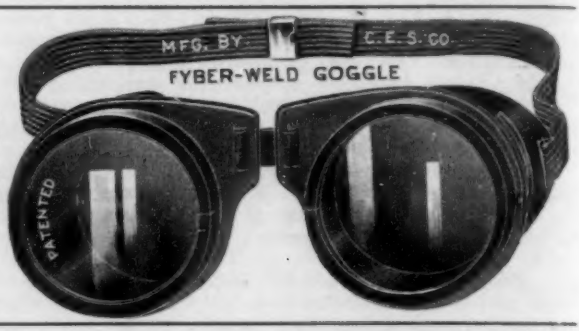

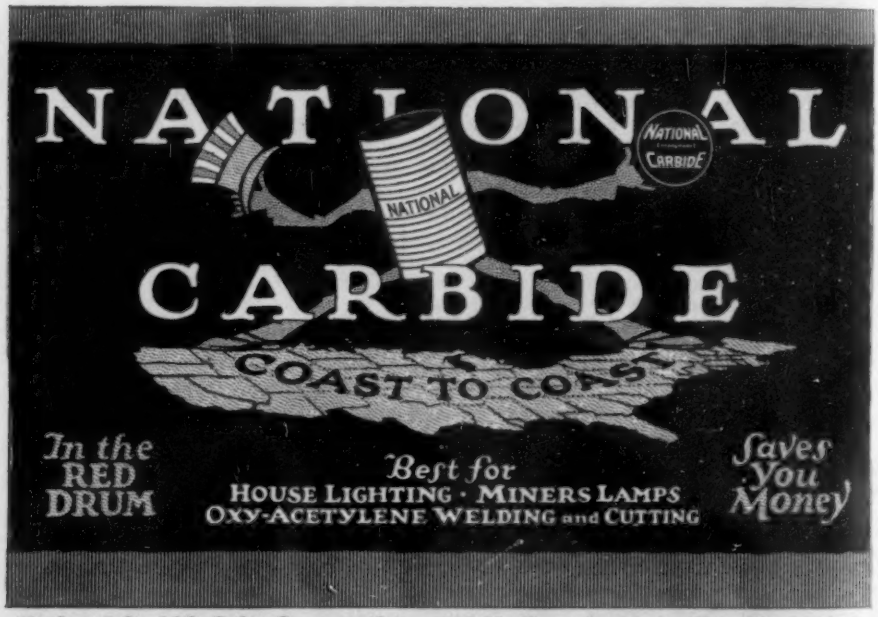

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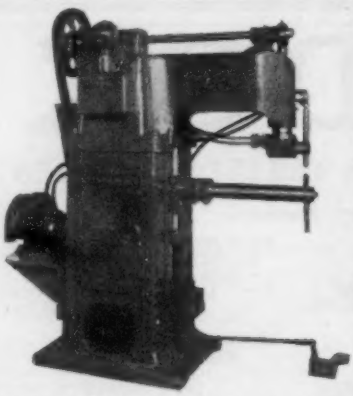

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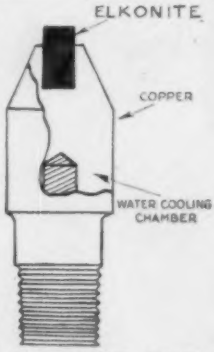

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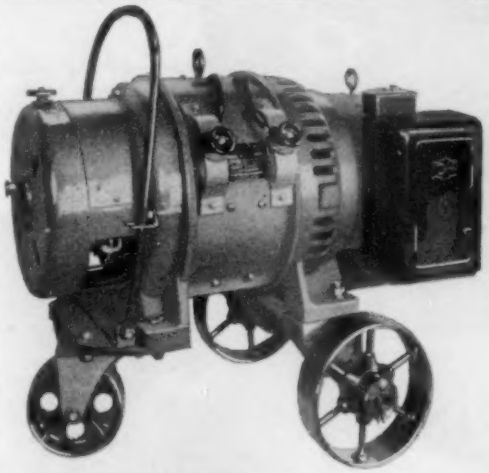

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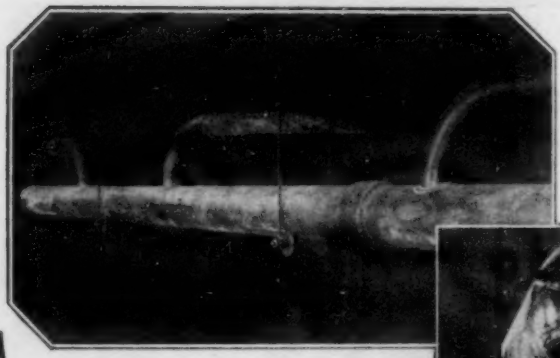
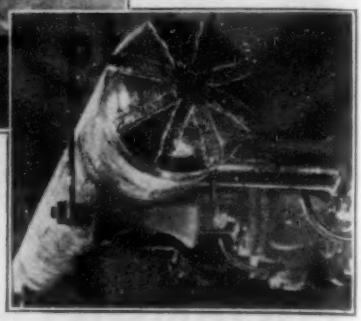


At left: The 10-inch main steam header, showing welded collar joints. Below: One of the arc-welded bull-nosed ends.



STEAM PIPING *in the* St. Luke's Hospital of Cleveland *electrically welded with* WILSON WIRE

IN building the St. Luke's Hospital, Cleveland, practically all the connections in the steam piping system were electric welded—and in all this electric welding work Wilson Wire was used *exclusively*.

The left-hand illustration above shows the method of joining lengths in the 10-inch main steam header. A small sealing weld was made at the scarfed ends, and then built up into a flush weld. Around the outside of this weld a steel collar was placed and welded to each pipe for mechanical strength. The joints in the curved pipes leading from the main steam header were made in the same way, and all flanges welded to the pipes.

The right-hand illustration shows how the bull-nosed ends were built up to terminate the high pressure headers—an excellent example of the *strength* secured by *electric welding*.

What Wilson "Color-tipt" Wire has proven to others it can prove to *you*, and in so doing will solve your welding problem. Whatever the industry, there is the *right* grade (analysis) of Wilson Wire for the particular metal *you* are welding—and every grade runs *uniform throughout*.

And wherever the industry there is a Wilson Model S Welding Machine that will meet *your* particular welding requirements and operating conditions—a one-arc gasoline-engine-driven, belt-driven or motor-driven unit, or a two-arc motor-driven unit, with capacities of 10-250, 10-300, 10-600, 15-500, 15-1000 amperes.

Write today for a sample of Wilson "Color-Tipt" Welding Wire, indicating the kind of metal you wish to weld. Also, ask for bulletins describing Wilson Welding Machines.

WILSON WELDER & METALS CO. INC., 16 WILSON BLDG., HOBOKEN, NEW JERSEY

WILSON

WELDING MACHINES AND WELDING WIRE

Our Advertisers Are Supporting the Society.

Uniform Quality Carbide

THERE is a real and thoroughly practical reason back of the statement that Union Carbide gives the highest uniform gas yield.

It is this.

No matter how carefully production is controlled, there is some variation in the grade and sizing of carbide. But only the highest quality carbide, that which conforms to most rigid specifications, is shipped to Union Carbide customers in blue and gray drums.

The Union Carbide Company has extensive and unrivaled facilities for using that carbide which doesn't conform to blue and gray drum carbide standards.

This means that Union Carbide customers get only the carbide with the highest uniform gas yield It means that every pound of Union Carbide, packed into the blue and gray drums, will give the user greatest return on his invest ment.

UNION CARBIDE SALES COMPANY

Unit of Union Carbide and Carbon Corporation

UCC

Carbide and Carbon Building, 30 East 42d Street, New York

Peoples Gas Building, Chicago, Ill. *Adam Grant Building*, San Francisco, Cal.

UNION CARBIDE WAREHOUSES IN 190 CITIES

There is no mystery in the success of

Prest-O-Lite
DISSOLVED ACETYLENE

A record of 23 years of uniform high quality, and delivery service from 37 plants and 102 warehouses, has established a national preference for Prest-O-Lite.

Tens of thousands of acetylene users rely on Prest-O-Lite for all their oxy-acetylene welding and cutting work.

Such confidence must be deserved.

THE PREST-O-LITE COMPANY, INC.
Unit of Union Carbide and Carbon Corporation

UCC

General Offices: Carbide and Carbon Building
30 East 42d St., New York
31 Plants—102 Warehouses

A plain statement of facts

MORE than twenty years ago the first commercial oxygen for welding and cutting was produced—Linde Oxygen.

From that day on, Linde has been the standard with which all others are compared.

It has always had by far the largest sale of any oxygen.

There are three reasons for this:

—uniform high quality

—immediate delivery

—Linde Process Service—that insures the most economical results for Linde customers.

THE LINDE AIR PRODUCTS CO.
Unit of Union Carbide and Carbon Corporation
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General Offices: Carbide and Carbon Building
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LINDE OXYGEN

No. 1 High Test Welding Rod

Oxweld's answer to the demand for stronger welds

HIGHER pressures and greater stresses require steel welds of greater strength. To answer this new demand, Oxweld made the No. 1 High Test Welding Rod.

Any operator can produce welds with greater tensile strength by using No. 1 H. T. Rod. This has been proved time and again in all kinds of industrial work. A recent test in the welding shop of an oil refinery showed an increase of 9,000 pounds in the tensile strength of test welds on the first trial.

Moreover, welders can work faster with Oxweld H. T. Rod. This reduces welding costs.

Wherever the strength of welds is an important factor, it will pay you to use Oxweld High Test Welding Rod.

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Oxweld

WELDING AND CUTTING APPARATUS

This
is G-E Arc Welding Service

The G-E Arc Welding School: Free instruction in arc welding. Conducted in the interest of better welding. The best-equipped and the best-known school of its kind.

G-E Arc Welding Specialists: Ready to serve you without obligation in the working out of any welding problem. Call your nearest G-E office.

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G-E Arc Welding and Cutting Manual: One of the most complete practical arc welding manuals in existence. 145 pages —195 illustrations. Invaluable to all operating executives interested in welding. Price $1.

A Store House of Information: Bulletins, pamphlets, descriptive leaflets, instruction books, etc. covering all types of equipment and all phases of welding work. You are welcome to copies.

This is G-E Arc Welding Service. Whether or not you use G-E equipment you may make use of this service. Your inquiries will be promptly attended to.

530-26D

GENERAL ELECTRIC

GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y., SALES OFFICES IN PRINCIPAL CITIES

Welded "for keeps"

Seams with the grip of a solid casting—that's what the welding superintendent requires. Such tough, lasting welds are being obtained with competent workmen, good welding equipment, and *G-E Welding electrodes.*

G-E welding electrodes are easily manipulated. Stable, smooth arcs practically prevent sputtering and spattering. Welders can do more work and better work with less fatigue.

General Electric manufactures an electrode exactly suited to each kind of weld.

Type "F" is a bare wire treated by a special General Electric process to obtain a stable, concentrated arc. It is used for general welding of steel.

Type "B" is best for automatic welding. The concentrated arc confined by encasing the flux around the core in the sheath gives remarkable penetration for higher-speed welding.

Type "A" is recommended for cast iron.

In absolute reliability of operation and overall efficiency, G-E arc welders are unequalled. They are available in all sizes, all types—for either hand or automatic operation—for one or more operators.

Special distributors for G-E welding electrodes are located throughout the country and are equipped to give you prompt service. Get in touch with the G-E Welding Electrode Distributor near you or write to the Merchandise Department, General Electric Company, Bridgeport, Connecticut.

550-202D

GENERAL ELECTRIC

MERCHANDISE DEPARTMENT, BRIDGEPORT, CONNECTICUT

The Advantages of Tobin Bronze Welding

ANACONDA

Tobin Bronze is unequalled for welding cast iron by the oxy-acetylene process. It has the following advantages:

The base metal need only be heated to a dull red as Tobin Bronze flows freely at 1650° F.

This low welding temperature eliminates special pre-heating and often makes dismantling unnecessary.

Shrinkage can be prevented and the original alignment of broken parts retained.

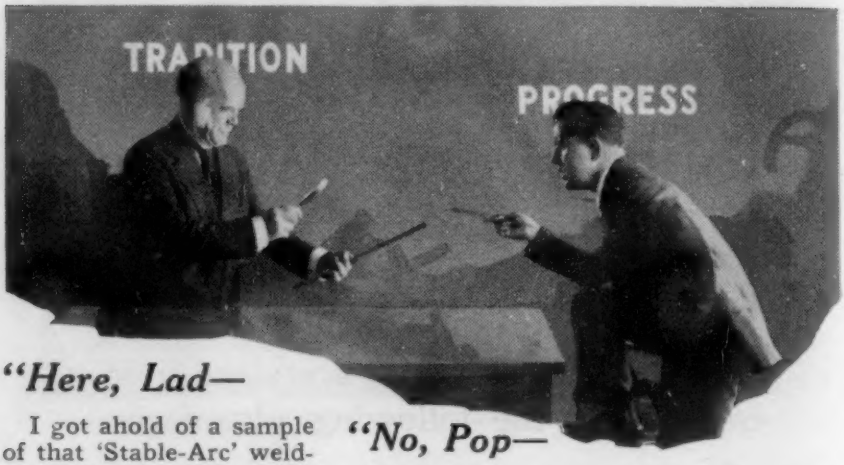
And most important of all, Tobin Bronze is stronger than cast iron.

Tobin Bronze Welding Rods are made solely by The American Brass Company and "TOBIN BRONZE" is stamped in the metal.

THE AMERICAN BRASS COMPANY
GENERAL OFFICES: WATERBURY, CONNECTICUT
Offices and Agencies in Principal Cities
Canadian Mill: Anaconda American Brass Ltd., New Toronto, Ont.

TOBIN BRONZE
REG. U.S. PAT. OFF.
WELDING RODS

Pop learns there is a difference in welding rods



"Here, Lad—

I got ahold of a sample of that 'Stable-Arc' welding rod that you tell me everyone has gone to. Frankly I don't see where it's any different from the regular rod we've been using."

Only "Stable-Arc" Welders have all these features

Variable Voltage.
Laminated Magnetic Circuit.
Separately-excited Generator Field.
Double Control of Welding Heat.
Steady Arc Throughout Entire Welding Range.
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Full Capacity for either Metallic or Carbon Arc Welding.

These features make welding easier. Results—better welds and greater output. Ask any Operator!

"No, Pop—

you're not supposed to *see* the difference but to HEAR it.

It's the operator who can SEE the difference in the free-flowing weld he makes.

He can FEEL the difference too because the Lincoln Stable-Arc BLUE rod is non-splashing.

But you should HEAR the difference from the operator—he needs the best rod there is to do the best job.

And you should HEAR the difference from our customers who would praise the work our operators turn out.

And that would mean more dollars for our shop.

And if you can't see the difference, you're color blind because the Stable-Arc rod is BLUE—but history fails to record a single case where a color-blind person has ever overlooked a greenback."

The Lincoln Electric Co., Dept. No. 22-6, Cleveland, Ohio

W-45

"Stable-Arc" LINCOLN WELDER

Our Advertisers Are Supporting the Society.

Roebling

IN the large important steel works; shipyards; industrial plants; mines; automobile shops; railroad shops and repair shops Roebling Welding Wire is demonstrating its efficiency and reliability. Roebling Electrodes are positively uniform throughout the same shipment and throughout all shipments.

John A. Roebling's Sons Company
Trenton, New Jersey

Mention the "Journal of the American Welding Society."

Here's a Remarkable New Torch

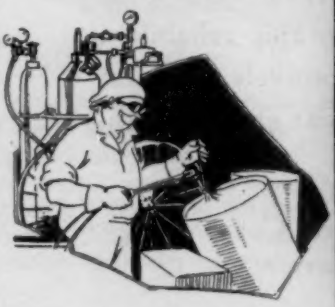
Cuts and Welds with the Same Tips. Just turn the tip to change the operation.

Another Milburn product that saves time, labor and gas. New Combination Cutting and Welding Torch Type TI. One Torch is all you need for cutting and welding. One set of tips is enough. A quarter turn of the tip makes the change from cutting to welding. In addition to this new feature the new TI Torch has the exclusive patented features which have enabled users of Milburn Torches to report savings of 20% and more and which have caused Milburn Torches to be standardized by large industrials after severe competitive tests. Learn more about this remarkable new torch.

Ask for Bulletin 354

THE ALEXANDER MILBURN COMPANY 1416-1428 W. Baltimore St. Baltimore, Md.

A Complete line of Torches, Regulators, Generators, Etc.



If You Want to Know Why

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OXY-ACETYLENE EQUIPMENT

Gives more satisfactory service. Operates with a lower gas cost. Costs less to maintain *than any other equipment*—

Write for Booklet - "FACTS"

THE BASTIAN-BLESSING CO.

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Proven, inexpensive, practical, and simple in its application to all classes of work involving the repair of medium and heavy size sections of iron and steel.

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CUT OFF ALONG THIS LINE

MEMBERSHIP APPLICATION BLANK

AMERICAN WELDING SOCIETY
33 WEST THIRTY-NINTH STREET
NEW YORK, N. Y.

.....192..

Secretary:

I hereby apply for Membership in the AMERICAN WELDING SOCIETY as a ..... Member and attach
(Note Grades on other side)
hereto remittance of $..... for first annual dues. Remittance will be refunded in the event of rejection of applicant. I also agree to abide by the Constitution and By-Laws of the Society.

Name .....

Present occupation .....

Name of Company and Address .....

Residence .....

Address for mailing .....

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.....

.....

Applicant is requested to state here length of welding experience and processes involved, also to record any technical or mechanical experience or special interest in the welding field.

References: (1. .....

(at least two) (2. .....

Proposed by .....

(See other side)

CUT OFF ALONG THIS LINE

QUALIFICATIONS FOR MEMBERSHIP

Extract from By-Laws

ARTICLE I.

Section 1. Individuals having received the approval of a majority of the Membership Committee shall become members of this Society upon the payment of dues, except in the cases of honorary members who shall be elected by unanimous vote of the full Board of Directors.

Section 2. Membership shall be divided into five classes:

Sustaining Members, being individuals or individuals delegated by corporations, firms, partnerships, etc., interested in the science and art of welding, with full rights of membership.

Annual dues..... ..... $100.00

Members, being individuals interested in the science and art of welding, with full rights of membership. Engineers or individuals competent by experience or training to plan or direct welding operations are eligible to this class.

Annual dues..... $20.00

Associate Members with right to vote but not to hold office, except in Sections as may be provided for by the By-Laws of the Section. Supervising welders, inspectors and skilled operators, with three or more years' practical experience in welding, are also eligible to this class.

Annual dues..... $10.00

Operating Members, who are welders or cutters by occupation, without the right to vote or hold office except in Sections as may be provided for by the By-Laws of the Sections.

Annual dues, United States and Canada $5.00
Other countries..... $10.00

Student Members, who are actually in attendance at any one of the recognized colleges and approved trade schools, without the right to vote or to hold office except in Sections as may be provided for by the By-Laws of the Section.

Annual dues..... $2.50

Where a *few cents* mean *more* dollars

This exhaust manifold represents a typical improvement made possible by better welding. It gives a higher efficiency than is possible with mechanical types of fittings. What is more, it is a more dependable job. There are fewer places where trouble can occur.

It is natural that PAGE Welding Wire was used in the manufacture of this exhaust main, where good work is so essential. PAGE Welding Wire assures uniform welds made at the lowest possible cost. Welders will tell you it costs less to use this better product, because it saves labor, equipment and time.

You can prove for yourself in your own way the quality of PAGE-ARMCO electrodes. Your name and address will bring samples for testing.

PAGE STEEL *and* WIRE COMPANY
Bridgeport, Connecticut

District Offices: Chicago New York Pittsburgh San Francisco
An Associate Company of the American Chain Company, Incorporated, Bridgeport, Conn.
In Canada—Frost Steel & Wire Co., Hamilton, Ontario

PAGE-ARMCO
PROCESSED
Welding Wire *and* Electrodes

AIR REDUCTION SALES COMPANY

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Charlotte, N. C.	Los Angeles	St. Louis
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Cleveland	Minneapolis	Wheeling, W. Va.

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